FIFTY-FIFTH ANNUAL REPORT

OF THE

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION

R. Y. WINTERS, Director

THE NORTH CAROLINA STATE COLLEGE OF AGRICULTURE AND ENGINEERING OF THE UNIVERSITY OF NORTH CAROLINA

AND

STATE DEPARTMENT OF AGRICULTURE COOPERATING

STATE COLLEGE STATION
RALEIGH

FOR THE FISCAL YEAR ENDING JUNE 30, 1932
PROGRESS REPORT FOR YEAR ENDING
DECEMBER 1, 1932

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C. H. HAMILTON ..... *Associate in Rural Sociology*

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H. B. MANN ..... *Associate in Soil Fertility Investigations*
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Coastal Plain Test Farm—Willard

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R. E. Currin, Jr.....*Assistant Director in Charge*
Wm. Allsbrook.....*Herdsman*
J. P. Young.....*Assistant Tobacco Investigations, U. S. Department of Agriculture*

FIFTY-FIFTH ANNUAL REPORT

OF THE

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION

FOR THE

YEAR ENDING JUNE 30, 1932

The Agricultural Experiment Station recently completed its fifty-fifth year of service to the people of North Carolina. During that period it has had an essential part in the social and economic progress of the state. While its services were established for the benefit of agriculture, the results of its research have contributed to the welfare of those who produce, those who market and transport, those who process or manufacture, and to those who consume agricultural products.

The Station has promoted and fostered worthwhile agricultural movements for farm organization and cooperation. As early as 1889 it established "Experimental Committees" with local Alliances, Granges, and Farmers' Clubs through which field tests were made and other sources of information supplied to the organizations and their membership. It has initiated and served farm groups through Farmers' Institutes, agricultural fairs, agricultural credit unions, seed improvement associations, and cooperative marketing groups.

The control measures for plant and animal diseases developed by this Station have reduced serious losses of plant and animal products on the farm, in transportation and on the markets. Contributions have been made to control measures for "wild fire", "mosaic", and wilt diseases of tobacco, leaf scorch of strawberries, blight of potatoes, anthracnose of cotton, anthracnose and cane blight of dewberries, and wilt and scurf of sweet potatoes. Studies for the control of tuberculosis and Texas fever of cattle, started in 1899, laid the foundation for the elimination of these diseases and the further development of the cattle industry in the state. Control measures for typhoid and diarrhea of poultry furnished information for materially reducing the losses from these diseases. Station workers have brought to the attention of farmers, Extension workers and teachers of the state the best information relating to these problems from other state and federal research agencies. Were the control measures now in practice by growers of the state suspended for one year, the losses would be many times greater than the entire cost of the research which established them.

Control measures for insects which have threatened plant and animal production have reduced this source of loss and improved the quality of plant and animal products. The more important contributions from this source include pioneer work for the control of cattle tick, and more recent work with stomach worms of sheep, boll weevil, tobacco flea bugs, the curculio, peach tree borers, the corn stalk borer, bill bug, potato beetle, the harlequin bug, and grain weevil.

The soil reseach of the Station has placed North Carolina among the leading states of the nation in accumulated knowledge of its soil resources and fertility problems. More than 80 percent of the land area of the state has been classified and mapped as to soil type. This work has been

supplemented with information regarding crop adaptation and fertilizer requirements of the principal soil types. These and other sources of information resulting from research are now being correlated for the purpose of establishing a more definite policy for land use and conservation.

The Station has contributed to the industrial development of the state through technical advice to manufacturers of chemicals, feeds, fertilizers, implements, and other materials used by farmers. The early chemical studies of mineral products for the Geological Survey contributed to the development of these resources. The improvements in quality of cotton and tobacco due to the introduction of new varieties and improved methods of fertilization and culture have also had their influence upon progress in manufacturing.

The results of research have protected farmers and industries to the extent of thousands of dollars from fradulent practices. Such services have included information and advice regarding improper fertilizers, insecticides, fungicides, and other patent chemicals and appliances unsuited to the purposes for which they were advertised. Similar activities have also been effective in checking the sale of poor quality and unadapted seeds.

Workers of the Experiment Station have developed and introduced into the state new crops and improved varieties of field crops, vegetables and fruits which have contributed to greater efficiency in production, better market quality, and new sources of income. In 1881 the Station started studies of soybeans, which demonstrated the value of this new crop through cultural experiments and chemical tests of its feeding value. The general distribution of soybean seed to North Carolina growers started an enterprise which later reached the value of more than $10,000,000 per year. The study of crimson clover in the late 80's and the distribution of ten pound samples of seed to 430 growers in 1892 introduced this important crop for the first time in the state. (See Bulletins 70, 98 and 133 of this Station). The distribution of improved varieties of bulbs, figs, grapes, peaches, dewberries, and strawberries in the early 90's had considerable influence upon the establishment of these fruits in the state. The development and introduction of new varieties of cotton, corn, soybeans, and tobacco have materially improved the efficiency of production and market quality of these crops.

Studies of forage crops, pasture grasses, pasture management and the nutritional properties of North Carolina grown feeds have supplied a better foundation for building the livestock industry of the state.

The studies of farm credit have pointed to the high cost of merchant credit and have suggested more economical sources of cash credit. (See Bulletins 270 and 271).

Results of farm management studies conducted in four areas of the state have furnished information for a more systematic and economical adjustment of crop and livestock on North Carolina farms. These studies have also supplied authentic information regarding production costs of crop and livestock products. (Bulletins 252, 260, 277 and 280).

Studies of North Carolina cotton with reference to spinning quality have formed a more intelligent basis for cotton improvement and marketing through cooperation. (See "A Study of Cotton Market Conditions in

North Carolina with a View to Their Improvement," 1917). In recent years the quality of cotton produced in the state has been changed from undesirable short staple to a position where two-thirds of the crop of the state, because of its longer staple, commands a premium of one-half to a cent a pound premium over the types previously grown. This improvement in quality and the development of cooperative marketing has converted the state from an exporter of low grade cotton to a producer of good quality of inch cotton largely used by mills of the state.

The studies of soil drainage and soil erosion control have contributed to safer farming and to more definite means of conserving soil fertility. (See Bulletins 71, 121, 234 and 236, Annual Reports 1917 through 1921)

Studies of standards of living among farm owners and tenants, and other social problems have supplied extension agents and teachers with more definite information for the establishment of a program to improve living conditions and rural organizations.

In summarizing these accomplishments, the Experiment Station does not assume credit for all of the changes in farm practice. The function of the Station has been largely that of searching for and supplying information. The changes in practice have been accomplished through the splendid cooperation of farmers, farm demonstration agents, agricultural teachers, agricultural papers, newspapers, and other agencies.

Through correspondence and conferences the research staff serves directly several thousand persons each year. These direct services include the identification of diseased specimens of plants and animals with recommended remedies and methods of prevention, identification and control measures for insect enemies, recommendations for the preparation of livestock rations from home-grown feeds, the testing of soils, good and poor, and recommending fertilizer and lime treatments for specific crops. Many of the requests concern new crops and fruits, new farm enterprises, and means of reorganizing the farm to meet changes in economic conditions.

The foregoing paragraphs have listed some of the more practical accomplishments promoted through the application of science to common problems. They would be incomplete and unfair to the workers who made them possible without some record of results which have been less direct in their practical application to agriculture, but more valuable in their contributions to the natural sciences. These have included improvements in chemical methods for the study of plant and animal products, life history studies of plant and animal diseases, contributions to the technical knowledge of plant and animal nutrition, studies of poisonous and medicinal plants, inheritance studies of plant and animal qualities, and other related subjects. These contributions are fundamental steps in the advancement of scientific knowledge. They are aids to other research workers and form an important part of the subject matter for the training of school and college students.

RESEARCH IN RELATION TO FUTURE AGRICULTURAL PROGRESS

Agriculture is an essential part of the social and economic structure of North Carolina. Only one other state of the Union has the advantages and responsibilities of so large a farm population. The future value of

this group to the state depends upon a better understanding of conditions as they are and a clearer vision for future planning.

Conditions of literacy and professional training have not only limited progress in agriculture, but have quite largely determined its course. The lack of professional training is still a handicap to efficient organization and management, to the profitable exchange of products and services, and to the development of cooperative enterprises.

While recent attention has been focused upon the influence of external conditions which affect agriculture, it is quite evident that internal conditions are equally responsible. Temporary legislative and scientific measures will undoubtedly give relief, but these can in no way replace the need for basic revisions in practice and the necessity for professional training.

Public institutions have contributed to the development of useful professions through research and education. They have also contributed to industrial development. The nature of industrial organization in larger units of capital and available specialists has made possible additional research which has contributed to industrial development. Specialized agricultural research and education is relatively young and has developed primarily in publicly supported institutions. Whether research is supported privately or publicly it is quite evident that the consuming public pay the cost and may enjoy its benefits to the extent the results become common knowledge and service.

The divergent opinions with reference to the conditions and needs of agriculture reflect to some extent, the vision of what part agriculture has taken and should take in the future community. On this account a clearer statement of needs and objectives is necessary if coordinated effort is to be expected. More definite facts of conditions, social and economic, are needed. With these in mind, the available segments of knowledge must be correlated and applied to the rebuilding of a more permanent system of agriculture. If the course of agriculture is to be effectively changed, more definite information will be required.

The agricultural population will contribute largely to the future citizenship of the state. The present social and economic conditions in agriculture will determine quite largely the nature of future citizenship in the state. The increase in tenancy will have its influence upon this problem. What are the true conditions? How can land tenure policies be changed to absorb more high school and college graduates, to cultivate land ownership and more intelligent land use? At present we have no clear conception of such plans. Lands are now occupied by farms that because of their contours and other properties, cannot support a reasonable standard of living. The developments now under consideration in the Tennessee River valley will bear directly upon this problem. Such projects will require a better understanding of the areas before definite planning is made possible. The annual losses from plant and animal diseases and parasites in North Carolina would make a permanent endowment for the study of preventive measures. The annual losses of soil fertility and reduction of crop yields due to soil erosion would rebuild the state's Greater University. Neither agriculture nor the state as a whole, can continue to absorb such losses.

The problems of agriculture cannot be solved at Raleigh, or at any other single point. The term "agriculture" in North Carolina is not

specific, it involves many farming regions differing in social, soil, climatic and economic advantages and disadvantages. The problems and needs of these regions or type areas, differ and if they are to be definitely influenced by constructive planning, true conditions must be known and the simplest tested schedule of development started. This will require more information than is now available. Investment in agricultural research, therefore, is simply an investment in the future social and economic welfare of the state.

THE SUPPORT OF AGRICULTURAL RESEARCH

The support of research in the Agricultural Experiment Station has been derived from the fertilizer tax fund of the State Department of Agriculture and from federal appropriations through the United States Department of Agriculture. Since 1877 the Experiment Station has had cooperative relations with the State Department of Agriculture and has shared in the use of the fertilizer tax funds. The functions of the State Department of Agriculture have included the administration of legislative control measures, agricultural research and marketing. The functions of the Agricultural Experiment Station have been primarily Agricultural research.

The Agricultural Experiment Station is supported and administered by authority of the United States Department of Agriculture, the State Department of Agriculture, and the North Carolina State College of Agriculture and Engineering. The federal support includes the Hatch Fund, established in 1887, $15,000.00; the Adams Fund of 1906, $15,000.00; and the Purnell Fund, of 1925, which reached the maximum of $60,000.00 in 1929.

The State fund has varied with the amount of the fertilizer tax fund, and with the cooperative agreements with the State Department of Agriculture. The following is a record of changes in State support of agricultural research during recent years:

CHANGES IN STATE SUPPORT OF AGRICULTURAL RESEARCH

Year	*Amount*
1924	$95,976.36
1925	62,000.00
1927	60,000.00
1932	41,500.00
1933	30,000.00
*1934	28,500.00

These changes have reduced the research personnel supported wholly or in part by the State fund from 25 to 11, and the research program to the extent of 46 projects.

COOPERATION

During the past year the Station has cooperated with seven Bureaus of the Federal Department of Agriculture in the study of regional agricultural problems peculiar to North Carolina and adjoining states. The recent extension of cooperative effort between adjoining states and federal agencies has brought to bear upon mutual problems a broader technical

*Recommended by Budget Commission.

attack, the elimination of duplication, and is promoting greater progress in common objectives. Plans are now under way for further developing cooperative relations.

PROGRESS OF ACTIVE PROJECTS

Changes in financial support on short notice have required the discontinuance of projects before completion, and other projects have been placed on the inactive list until funds are available or more important work completed. The present program of research is directed toward the study of a few of the larger problems and is organized to promote cooperative effort among staff members and with other agencies engaged in related research. The present cooperative spirit of those engaged in research is undoubtedly the greatest asset of the Station.

For the purpose of relating individual projects to common objectives, this report of progress is divided into three groups rather than the usual nine departmental divisions. The logical grouping of projects should give a clearer picture of the research program which will, in part, compensate for the lack of departmental credit. The three groups are as follows:

1. Research which has for its purpose extending and preserving the usefulness of land.
2. Studies of farm enterprises which will give a better understanding of their relationship to the farm business as a whole, and to efficient operation.
3. Studies of human factors in agriculture which will contribute to the improvement of social and physical environment.

SOIL RESEARCH

Differences in the chemical and physical properties of the soil have had a direct influence upon the distribution of native plants and the adapted types of agriculture. Natural soil differences have also had an influence upon rural and urban community development. Under continuous cropping the natural properties of soils have been changed. Certain soils have become deficient in essential plant food elements and organic matter has been used or washed away by erosion.

Successful soil management and maintenance is dependent upon a more thorough knowledge of the state's soil resources, their physical and chemical properties and adapted uses. The soil research is directed to this purpose and includes the recording and mapping of soil resources by counties, physical and chemical studies of soil types, and studies for the control of soil moisture and washing.

The Soil Survey. The soil survey, which is conducted in cooperation with the Federal Bureau of Chemistry and Soils, has been continued actively during the year. Field work in Brunswick and Washington counties has been completed and detailed reports have been prepared for publication. In addition to these counties, one-half of the field work in Chatham and two-thirds of the work in Surry county has been done. To date four-fifths of the state has been surveyed and recorded.

The information supplied by these reports is invaluable for the location of all outlying field research and for interpreting field results for other areas of similar soil conditions.

This systematic accumulation of data has made it possible for the research staff to serve directly several thousand farmers with reference to their soil problems during the past year. During the year more than two thousand samples of soils were sent or brought in by farmers for identification and recommendation for soil treatment and management. The demands for these services are increasing each year. (C. B. Williams, W. A. Davis, and E. F. Goldston).

Chemical and Physical Properties of the Durham Series of Soils. Analyses of colloids from the subsoils of samples of Durham fine sandy loam derived from gneiss and Durham sandy loam derived from granite were made with the following results:

	Durham Fine Sandy Loam Colloid—Percent	*Durham Sandy Loam Colloid—Percent*
Moisture	3.14	5.05
SiO_2	42.10	40.40
TiO_2	1.16	1.68
Fe_2O_3	8.93	13.98
Al_2O_3	32.85	28.71
Total sesquioxides	41.78	42.69
SiO_2/Al_2O_3 (mol. ratio)	2.22	2.39

These analyses show considerable similarity, the principal difference being the greater amount of Fe_2O_3 in the colloid from the granite, together with a smaller amount of Al_2O_3. The total percent of sesquioxides in each sample, however, is very close together.

From the silica-alumina ratios of 2.22 and 2.39, the two soils are shown to be non-lateritic in character, and therefore younger than the Cecil soils derived from the same rocks which are shown to be lateritic by analyses published by the Bureau of Chemistry and Soils.

Color analyses of a dried sample of each colloid was made by spinning a disc covered with a paste made of the soil and then dried with Munsel color discs until the color displayed by the soil matched the color resulting from the following percentages of the red, black, yellow and white discs.

	Durham Fine Sandy Loam Colloid (B horizon)	*Durham Sandy Loam Colloid (B horizon)*
	Percent	*Percent*
Red	23	29
Black	49	28
Yellow	22	31
White	6	12

(W. B. Cobb.)

Magnesia Deficiencies of Sandy Soil Types. A lysimeter and cultural test to determine the effect of calcitic lime and potash salts on the availability of soil magnesium has given no evidence of any influence on the potash fertilization. Calcitic lime continues after five years to depress the solubility of magnesium in the soil and the availability of this element to soybean plants.

Some evidence obtained during the past year indicates that other forms of calcium, other than the carbonate, may decrease the availability of soil magnesium. The results do not yet warrant publication. (L. G. Willis).

Absorption of Iron from Highly Organic Acid Soils. This project was designed to attempt an explanation of the increase in absorption of iron by corn plants grown on these soils as a result of liming. Since starting work on this project a year ago, one report has been published under the title of "Oxidation Reduction Potential and the Hydrogen-ion Concentration of a Soil". This report presents data to show that one of the soils under investigation varies in reductiveness with the pH values induced by liming.

Pot culture experiments have shown that liming an acid peat soil increases the iron content of corn plants, but applications of copper sulphate reduce the amount of iron absorbed below that from the corresponding soil receiving lime alone.

Organic matter dissolved from an acid peat soil by sodium hydroxide and purified by electrodialysis has a potential that varies inversely with the pH values resulting from the additions of alkaline hydroxides to the acid organic matter. Tentative conclusions are drawn (1) that partial oxidation of this organic matter may take place without the intervention of microorganisms; (2) that the acceleration of carbon dioxide evolution from soil organic matter by microorganisms as a result of liming is better related to the greater dissociation of the calcium salts of the organic matter than to an increase in the activity of any oxidizing system; (3) and that the greater absorption of iron at the higher pH values is associated with the increase in reductiveness brought about by the greater dissociation of the organic anions. (L. G. Willis).

Soil Erosion and Moisture Conservation. It has been estimated by Lutz[1] that the annual loss to North Carolina farm lands due to soil washing is approximately $66,000,000. No state or community can continue successful operation with such a drain upon its resources.

The destructive work of soil erosion is marked by badly gullied idle fields, by lands that have not yet gullied but which have had much of the top soil removed by sheet erosion, and by the deposit of sand and mud in streams and reservoirs. The future welfare of the population which these lands should support depend upon practical means of checking further destruction of good lands and the reclaiming of gullied lands to useful purposes. The problem is one of public concern as well as that of private landowners.

The research program projected toward these objectives is conducted in cooperation with the Federal Bureaus of Agricultural Engineering, Chemistry and Soils, the State Department of Agriculture, and the Department of Conservation and Development. The projects under the erosion and moisture conservation program may be included in four groups, according to objectives, as follows:

1. Those projects which have for their purpose studies of the nature of soil erosion and moisture under varying conditions of soil and rainfall.
2. Studies of the relation of cropping systems to the rate and kind of erosion.
3. The effectiveness of terraces varying in slope, length, and vertical distance.
4. The effectiveness and economy of plantings, dams, and other obstacles for checking gullies and washing on steep slopes.

The program outlined in more detail in the 1931 reports has been continued during the past year.

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[1] Lutz, J. F. The Farmer's Highest Tax—Soil Erosion. N. C. State Agriculturist, February, 1932.

FARM ENTERPRISES

The individual farm derives its income from the products of one or more crops and livestock. The separate crop or livestock units are known as farm enterprises. The enterprises of the Coastal Plain farm might consist of cotton, tobacco, peanuts, corn, and swine. The enterprises of a Piedmont farm might consist of small grain, dairy cattle and hay. In the Mountain area the farm might choose a part of its enterprises from beef cattle, sheep, dairy cattle, hay crops, fruits and vegetables.

Farmers of the state can continue to use the services and products of others only to the extent their farm enterprises return a profit. When the individual or combined enterprises fail to return a profit, the standard of living and farm capital become involved. Recent unfavorable farm prices and inefficient farm practices have lowered the farm standard of living and reduced farm capital.

Production control measures which receive regional and national farm cooperation should have a definite influence upon the price of farm commodities, and may effect relative prices between farm commodities and those products which farmers must buy. There will still remain, however, the need for the adjustment and efficient management of farm enterprises.

The research program with farm enterprises deals with farm organization for the more effective adjustment of farm enterprises and management problems which effect the efficient operation of individual enterprises. The following pages contain reports of progress in projects chosen by members of the Experiment Station staff as essential to advancement in North Carolina farm enterprises:

Farm Reorganization. The objectives of this project are (1) to study the possibilities of reorganizing farms so that field arrangement may be improved, systematic crop rotations established, and more efficient equipment employed in order to increase farm incomes; (2) to find out the total and cash cost of such reorganization work under actual farm conditions; and (3) to study the physical and personnel limitations to the suggested changes in the farming systems. In cooperation with the Bureau of Public Roads, U. S. Department of Agriculture, this work was started in 1930 when 13 farms in central North Carolina were used as the basis for planning the revised farming systems. These plans have been accepted by the cooperating farmers but have not been followed completely, due to low farm incomes that have acted as a deterrent to making changes. Work is being continued with the farmers and most of the proposed reorganization work will be carried out. Completion will be delayed, however, to a later date than was at first planned. Some terracing, draining and clearing has been done during the year on most of these farms with the adoption of the complete plan in mind as soon as possible (R. H. Rogers).

Farm Organization and Management of Cropper Farms. This project has been under way since 1928. One bulletin entitled, "Credit Problems of North Carolina Cropper Farmers," has been published. In the 1931 report information was published on the income of 62 of the farms under investigation. During the past year farm maps were made of forty-one farms. (R. H. Rogers).

The Cost of Producing North Carolina Farm Products. The work on this project has been practically completed. The necessary statistical tables have been prepared and are ready for publication. A mimeographed report will be issued in 1933. (R. H. Rogers).

Methods and Practices Employed in the Production of Cotton and Tobacco. This study is being made in order to determine the details of producing these major cash crops, the various cultural practices employed and the variations in production costs resulting from the different practices. From data thus obtained, improved practices may be suggested whereby production costs can be lowered and incomes improved on similar farms in the state. This project was started in 1930, and during the past year detailed records of production have been kept on 26 cotton farms and 8 tobacco farms. The summary of the 1931 cotton study is presented in Table 1. The results of the study on the tobacco farms are shown in Table 2. This work is being continued in 1932 with but little change in the personnel of cooperating farmers. (R. H. Rogers).

TABLE 1.—SUMMARY OF COTTON COST STUDY, 1931.

293.8 Acres—26 Farms—Johnston and Wayne Counties.

Item	Average Cost per Acre $	Percentage of Total Average Cost	Acre Cost on Low Cost Farm $	Acre Cost on High Cost Farm $	Acre Cost on High Yield Farm $
Man labor	5.23	15.0	4.01	5.53	4.01
Power (horse, mule, tractor)	6.23	17.9	5.28	5.29	5.60
Seed	.94	2.7	.70	1.75	1.02
Fertilizer	6.05	17.4	5.22	4.42	8.49
Poison material	.48	1.4	.....	.....	.....
Picking	5 01	14.4	6.61	4.00	8.93
Ginning	.83	2.4	2.25	1.45	2.65
Hauling	1.85	5.3	1.91	.85	1.29
Equipment & Miscellaneous	1.25	3.6	1.25	1.25	1.25
Land charge	6.93	19.9	7.00	6.80	7.00
Total charge	34.80	100.0	34.23	31.34	40.24
Seed credit	4.33	.....	6.20	2.73	6.98
Net cost per Acre	30.47	.....	28.03	28.61	33.26
Yield per Acre (lbs. lint)	415.4	.....	565.0	231.5	600.0
Cost per lb. of lint (cents)	7.33	.....	4.96	12.35	5.54

ROTATION OF CROPS IN RELATION TO FARM ENTERPRISES

If North Carolina agriculture is to become less speculative and less hazardous it must become more stable as to self support, and more flexible to the selection of farm enterprises. Information upon crop rotation and crop utilization is essential to this change. The research program directed toward this objective includes studies which measure the influence of certain crops upon succeeding crops, the fertilizer requirements of crops grown in rotation and the advantages of utilizing certain crops in the rotation by livestock. These studies are regional with reference to the major cropping and soil areas of the state. The studies are conducted on the Central and Branch Stations of the state.

TABLE 2.—SUMMARY OF TOBACCO COST STUDY, 1931.

34.7 Acres—8 Farms—Johnston and Wayne Counties.

Item	Average Cost Per Acre $	Percentage of Total Average Cost	Acre Cost on Low Cost Farm $	Acre Cost on High Cost Farm $	Acre Cost on High Yield Farm $
Man labor	12.12	12.2	4.94	15.92	9.28
Horse labor (horse, mule tractor)	5.89	5.9	4.50	5.46	4.33
Fertilizer	14.93	15.1	12.27	19.77	14.28
Plant bed material	1.08	1.1	.81	.74	1.00
Poison	.36	.4	.....	.....	.....
Barning	18.35	17.6	15.72	17.95	15.33
Curing	6.33	6.4	4.29	7.89	6.67
Fuel	3.58	3.6	2.14	3.16	4.16
Twine	.45	.6	.39	.57	.56
Assorting	11.84	11.9	6.27	9.64	15.15
Hauling	4.53	4.6	.....	1.89	6.26
Warehouse charges	5.60	5.5	5.07	4.12	4.77
Equipment and miscellaneous	1.15	1.0	1.15	1.15	1.15
Building	5.67	5.8	2.04	5.26	6.67
Tobacco sticks	1.22	1.2	.76	.79	1.25
Land charge	7.00	7.1	7.00	7.00	7.00
Total Cost	98.96	100.0	67.35	101.31	97.86
Scrap credit	1.42	.....	1.02	.....	1.11
Net Cost	97.55	.....	66.33	101.31	96.75
Yield per acre (pounds)	984	.....	836.7	771.5	1,212
Net Cost per pound (cents)	9.9	.....	7.93	13.1	7.98

Four-year Rotation with Tobacco. This rotation, begun in 1911, consists of the following:

1st year—Tobacco, with crimson clover sown in fall;
2nd year—Corn;
3rd year—Winter oats, followed by soybeans grown and plowed in and seeded to orchard and redtop grasses;
4th year—Grasses.

The fertility of the soil has been improved under this rotation and practically all of the root diseases of tobacco common to this section have been kept under control. It has become necessary, however, to increase the phosphoric acid and potash supplies of the fertilizer mixture in order to maintain the quality of the tobacco. The yield of tobacco has been on the average good, ranging from 1200 to 1600 pounds per acre. (E. G. Moss, cooperation Bureau of Plant Industry, Tobacco Branch Station, Oxford, N. C.).

Effect of Soybeans Preceding the Tobacco Crop. The object of this experiment is to see if sufficient nitrogen can be grown to supply the nitrogen requirements of the tobacco, and to compare the quality of the cured leaf of such tobacco with that grown under normal fertilization with commercial mixtures. In the formal case, no commercial nitrogen has

been added since the experiment was started in 1912, but liberal applications of sulphate of potash and superphosphate have been applied under the crop.

It has been found that the quality of crop produced from nitrogen supplied by soybeans has not been as good as that produced on less fertile soil from additions of commercial nitrogen. Apparently such a practice might be more widely used on the Coastal Plain soils than on the Durham and Granville series of the Piedmont section of the state. (E. G. Moss, cooperation Bureau of Plant Industry, Tobacco Branch Station, Oxford, N. C.).

The Influence of Preceding Crops upon the Yield and Quality of Tobacco, Corn and Cotton. The object of this experiment, started in 1916, is to study the yield and quality of tobacco, and yields of corn and cotton after vetch, crimson clover, cowpeas, soybeans, fallow, grass and check. Sixty-three field plats are being used to measure these effects.

The nitrogen which was accumulated from year to year by growing and plowing under hairy vetch and crimson clover was such that a poor quality of tobacco resulted. As a result, the potash and phosphoric acid have been increased in these plats with a corresponding reduction of commercial nitrogen, since which a slightly better quality of tobacco is produced. Tobacco grown after cowpeas and soybeans was somewhat better than that grown after vetch and clover. As previously reported, the best tobacco produced in this series of plats was on those plats which were allowed to grow up in weeds in the year prior to tobacco. The yield of corn was greater after vetch, with that following after crimson clover a close second. In some seasons slight difficulty has been experienced in securing a good stand of cotton following vetch and clover plowed under, but in years when the stand of cotton was comparable to the stand on the other plats, the yield of the cotton was somewhat better following vetch and clover than after cowpeas and soybeans. (E. G. Moss, cooperation Bureau of Plant Industry, Tobacco Branch Station, Oxford, N. C.).

Fertilizer and Lime requirements for Corn and Soybeans Grown in Rotation, the Soybeans Being Utilized for Seed Production in One Series and for Hay Production in Another on Field W (Okenee Fine Sandy Loam). This experiment is being conducted to determine the best fertilizer for corn, soybeans (for seed), and soybeans (for hay); and to show the effect upon succeeding crops of corn of picking soybeans for seed versus cutting them for hay when grown in rotation with the corn. The results from this work, which was started in 1926, have shown conclusively the advantages in both fertility of soil and yield and quality of crops due to picking the soybeans for seed. (C. B. Williams, H. B. Mann and R. E. Currin, Upper Coastal Plain Branch Station, Rocky Mount, N. C.)

Study of Yields and Quality of Succeeding Crops When Cotton, Corn, Small Grain and Peanuts are Grown Continuously and When They are Combined in 2, 3 and 4-Year Rotations on Field D-1, (Norfolk Sandy Loam). This experiment was made to study the yields and quality of succeeding crops and their effect in turn upon the fertility of the soil when cotton, corn, peanuts and small grain are grown continuously and when they are combined in 2, 3 and 4-year rotations.

This work has been continuous since 1924, some of the results now being prepared for publication. The yields of the crops in the one and two-year rotations are decreasing, while those in the 3 and 4-year rotations are gradually increasing. Corn and peanut yields have decreased more rapidly than has cotton in the one and two-year rotations.

The beneficial effect of good rotations was very marked this year due to the dry season. Crops grown on soils which have had very little organic matter turned under suffered much more severely from the drouth than did others grown where cover crops had been turned under. (C. B. Williams, H. B. Mann and R. E. Currin, Upper Coastal Plain Station).

Fertilizer Requirements of Tobacco Grown in Rotation with Oats, Soybeans and Rye. These tests, started in 1911, consist of seventy-two 1/40 acre plats, half of which have had three and four applications of dolomitic limestone once every third year, beginning in 1919. The cropping system which has been used on the plats is as follows:

1st year—Tobacco, followed by winter oats;
2nd year—Oats cut for hay, followed by soybeans;
3rd year—Rye, harvested for seed, the land being left fallow, followed by tobacco the succeeding year.

All root diseases have been kept under control in following this rotational system.

On the unlined plats, cottonseed meal has given best results, with nitrate of soda coming second. On the limed plats, ammonium sulphate almost equalled the nitrate of soda, with cottonseed meal still in first place. On plats receiving a mixture of nitrate of soda, sulphate of ammonia, cottonseed meal and dried blood, results were slightly better than those obtained where only one source of nitrogen was used. Basic slag and bone meal as sources of phosphoric acid for tobacco have been found to be too slow in their actions. (E. G. Moss, cooperation Bureau of Plant Industry, Tobacco Branch Station, Oxford, N. C.)

Fertilizer and Lime Requirements for Crops in a 2-year Rotation of Corn; Oats-and-Vetch, Soybeans (turned under); Soybeans (for seed), Rye (turned under). (Dunbar Fine Sandy Loam). This experiment was made to determine the best fertilization program to follow for the crops of the rotation. Field experiments were started in 1915 and have been run continuously. For the production of corn, oats-and-vetch and soybeans (for seed), the use of a complete fertilizer has been found advisable. Lime has increased the yields of both corn and soybeans. However, the large amounts of lime (one ton every three years) has greatly increased the root-rot of the corn. This disease has been checked on those plats which received high amounts of potash. A manganese deficiency chlorosis of the soybeans has developed on the limed series of the plats. Lime has not, however, materially affected the yield of oat-and-vetch hay, but its use has increased the amount of legumes in the hay and reduced the amount of oats. (C. B. Williams, W. H. Rankin and Chas. E. Dearing, Coastal Plain Branch Station, Willard, N. C.)

Fertilizer and Lime Requirements of Crops Grown in a 3-Year Rotation of Corn, Oats-and-Vetch and Soybeans (Dunbar fine sandy loam). This experiment was started in 1918 to determine whether or not the fertilizer

requirements of crops could be determined by applying the same amount of plant nutrients that are removed by the crops. From results secured, it is quite evident that the fertilizer requirements of crops cannot be determined in this way. The crops take up very much larger amounts of both nitrogen and potash than is economical to apply. The use of lime in addition to this heavy fertilization has not been profitable. The use of the larger amounts of lime has induced manganese chlorosis of legumes and increased the amount of corn root-rot. (C. B. Williams, W. H. Rankin and Chas. E. Dearing, Coastal Plain Branch Station, Willard, N. C.)

Fertilizer and Lime Requirements for Corn and Soybeans Grown in Rotation, the Soybeans Being Utilized for Seed Production in One Series and for Hay Production in Another (Muck). This experiment is being conducted to determine the best fertilization for corn, soybeans (for seed) and soybeans (for hay); and to show the effect upon succeeding crops of corn of picking the soybeans for seed versus cutting them for hay when grown.

From results secured since starting the experiment in 1928, superphosphate used either with nitrogen, or nitrogen and potash has reduced the yields of corn and soybeans for both seed and hay. The use of superphosphate alone has not been as injurious to the crops as when applied with nitrate of soda. Nitrogen and potash mixtures without phosphoric acid have given the largest yields of all crops. Up to this time there has been very little difference in the average yields of corn following soybeans cut and picked on this soil. The first year the corn yields were larger following soybeans cut for hay. However, in 1931 the yields were larger following the soybeans picked for seed. (C. B. Williams, W. H. Rankin and J. L. Rea, Jr., Blackland Branch Station, Wenona, N. C.)

Rock Phosphate, Superphosphate and Duplex Basic Slag Compared as Sources of Phosphoric Acid for Corn, Oats, and Irish Potatoes Grown in a Three-year Rotation (Muck). This experiment was designed to determine the efficiency of various phosphate carriers and varying amounts and proportions of commercial fertilizers used on muck soil. A detailed report on this work which was started in 1923 is now in the press.

There has been very little response by the crops to any of the phosphate carriers. Lime and potash have been shown to be the limiting factors for crop production on the soil. Phosphate used without potash has been injurious, as is shown by the results of 1931 given below.

	Yield per Acre		
	Corn Bushels	Oat Hay Pounds	Irish Potatoes Bushels
NPK	45.4	7,060	187.4
NK	60.7	7,920	102.4
NP	27.1	5,120	77.7
No fertilizer	48.2	5,100	79.9

Soybeans, fertilized with phosphate without supplementary potash, shed their foliage during drouths in the summer and sent out new shoots after the rains came. This greatly reduced the yields of the beans both for hay and for seed. (C. B. Williams, W. H. Rankin and J. L. Rea, Jr., Blackland Branch Station, Wenona, N. C.)

Fertilizer Requirements of Corn, Wheat and Soybeans in Rotation on Field A (Toxaway loam). This experiment has been in operation twenty-two years with minor modifications.

The yields of corn, wheat and soybeans obtained from the several treatments in the experiment bear out the previous conclusion that phosphoric acid is the most essential of the three fertilizer constituents and that a complete fertilizer for each crop with one ton of limestone, applied once in the rotation, has produced more economical crop yields.

The proportions of nitrogen, phosphoric acid and potash and the amount of complete fertilizer to use per acre on these crops for best returns on this type of soil, and other river bottom soils of the Mountain section, have been determined mainly from results secured in this experiment and have been given to farmers of this section of the state.

Like the results of previous year, those plats of this field receiving the higher applications of phosphoric acid, with normal amounts of potash and nitrogen have produced largest yields during the year. (C. B. Williams, W. H. Rankin and S. C. Clapp, Mountain Branch Station, Swanannoa, N. C.

Fertilizer and Lime Requirements of Irish Potatoes, Wheat and Soybeans Grown in a Rotation on Field B (Toxaway loam). In this experiment, started in 1915, the yields have shown that the use of a complete fertilizer is more economical for all the crops. The amount of fertilizer to use per acre and different proportions of phosphoric acid, nitrogen and potash have been studied.

Those plats which have received a complete fertilizer for each crop, with a supplemental application of limestone once in the rotation, have produced largest yields of wheat and soybeans, but the yield of Irish potatoes was greatly reduced through the ravages of scab of the tubers when the limestone was added alone or with complete fertilizer.

In a comparison of sulphate of potash, muriate of potash and kainit as single sources of potash, there has been very little difference in the yields of wheat and soybeans, but the yield of Irish potatoes shows a slight difference in favor of the sulphate of potash as the carrier of this constituent for this soil. (C. B. Williams, W. H. Rankin and S. C. Clapp, Mountain Branch Station, Swannanoa, N. C.)

Rock Phosphate, Superphosphate and Basic Slag as Sources of Phosphoric Acid for Corn, Wheat and Soybeans in Rotation on Field G-2 (Toxaway loam). This experiment, started fourteen years ago, is devoted to a comparison of superphosphate, basic slag and soft phosphate as sources of phosphoric acid in producing corn, wheat and soybeans grown in rotation. The data thus far obtained has shown that superphosphate is the most effective source of phosphoric acid for all of the crops of the rotation. The results of 1931 were very similar to those secured in previous years. (C. B. Williams, W. H. Rankin and S. C. Clapp, Mountain Branch Station, Swannanoa, N. C.)

Rock Phosphate and Superphosphate Compared as Sources of Phosphoric Acid for Corn, Oats, Wheat and Soybeans in Rotation on Field G (Toxaway loam). This experiment has been in progress twenty-two years. Superphosphate has been found on an average to produce slightly larger yields than has rock phosphate used as the sources of phosphoric acid in a complete fertilizer. (C. B. Williams, W. H. Rankin and S. C. Clapp, Mountain Branch Station, Swannanoa, N. C.)

Comparison of Rock Phosphate and Superphosphate for Corn and Crimson Clover in a One-Year Rotation on Field G-2 (Toxaway loam). The object of this test is to compare superphosphate and rock phosphate as carriers of phosphoric acid with potash for corn when crimson clover is grown after the corn as a winter cover crop and turned under each spring.

Yields, covering a period of nineteen years, show that when these two phosphatic materials are used separately at rates supplying equal amounts of phosphoric acid per acre with potash from manure salt, the superphosphate has yielded 4.4 bushels of corn more per acre than did the use of finely ground phosphate rock. When the latter with potash was used at a four-time normal rate, it produced on an average only 0.4 bushels more than did the superphosphate used at a normal rate with potash from manure salt. (C. B. Williams, W. H. Rankin and S. C. Clapp, Mountain Branch Station, Swannanoa, N. C.)

Fertilizer and Lime Requirements for Cotton, Rye, Corn, Wheat and Red Clover Grown in Rotation on Fields A, B and C (Cecil clay loam). This project has as its objective (1) the determination of the plant nutrient deficiencies of this type of soil; (2) the proper proportions of nitrogen, phosphoric acid, and potash for the leading field crops; (3) the best quantity of fertilizer per acre; and (4) to study the symptoms of any nutrient deficiencies which may develop and their effect on the growth and yield of crops of the rotation. This study has been carried on continuously since 1903 with slight modification with and without supplemental applications of limestone to half of all plats.

Results thus far secured have shown that phosphoric acid is the most important nutrient to be supplied for the production of most profitable yields of corn, wheat, red clover and cotton, with nitrogen ranking second in importance.

Lime phosphoric acid and potash have been found necessary for the successful growth of red clover. The yields of wheat on Field A and corn on Field B for 1931 add further evidence to these general conclusions. (C. B. Williams, W. H. Rankin and J. W. Hendricks, Piedmont Branch Station, Statesville, N. C.)

Studies of the Efficiency of Superphosphate and Rock Phosphate as Sources of Phosphoric Acid on Field G (Cecil clay loam). The object of this experiment is to compare superphosphate and rock phosphate as sources of phosphoric acid for corn, wheat and red clover when the crops are grown in a three-year rotation on this soil. The experiment has been under way since 1910, and from five-year average the yields of corn produced show that 50 pounds of phosphoric acid from superphosphate with limestone is more efficient than the use of 150, 300, 450, 600, 900 and 1200 pounds, respectively, of phosphoric acid from rock phosphate every

three years with limestone. On the other hand, without limestone larger yields resulted from the use of the larger amounts of phosphoric acid (600, 900 and 1200 pounds) every three years from rock phosphate. (C. B. Williams, W. H. Rankin and J. W. Hendricks, Piedmont Branch Station, Statesville, N. C.)

Effect of Rotation Upon Succeeding Crops When Normal Amounts of Fertilizer are Used on Field D (Cecil clay loam). The primary object of this experiment is to study the effects of 1, 2 and 3-year rotations on the production of succeeding crops. Results from this project, which has been in progress 22 years, show that higher yields of both corn and wheat are produced on those plats in a 3-year rotation of corn and cowpeas, wheat, and red clover, than when these crops were grown in 1 and 2-year rotations. (C. B. Williams, W. H. Rankin and J. W. Hendricks, Piedmont Branch Station, Statesville, N. C.)

Study of the Utilization of Crops Grown in Rotation with Cotton by Two Different Methods. This experiment, carried on at the Upper Coastal Plain Branch Station farm, is being made to compare crop yields, financial returns and fertility of the soil under two methods of utilizing crops grown on it in a three-year rotation with cotton:

(1) By hogging off all crops except cotton.
(2) By harvesting certain crops and turning under the cover crops and crop residues.

The rotation consists of cotton, rye and crimson clover, soybeans and corn.

Since the inauguration of this experiment in 1927 the yields from the field that is hogged off and normally fertilized have been gradually increasing as compared with those from the fields on which credit is taken for the fertilizing value of supplementary feeds given hogs and on which the crops are harvested. The 1931 cotton crop indicates that the fertility of the latter two fields is approximately the same, but about 27 percent less than where the crops are hogged off and no credit taken for the fertilizing value of the supplementary feedstuffs fed. (Earl H. Hostetler, H. B. Mann and R. E. Currin).

Dairying as a Supplementary Enterprise to Cotton Farming. Previous studies have indicated the advantages of rotations in the production of cotton. This project, started in 1930, is designed to study the effects of such rotation upon the cotton enterprise when forage crops of the rotation are used to maintain a small herd of dairy cattle. The rotation consists of cotton, rye and vetch, corn, barley and vetch, and lespedeza. Records of cost and returns are taken on all crops and the dairy unit.

Seven cows and one heifer are allotted to this project which studies the relation of a dairy herd to a cotton-corn-legume rotation. The manure from the herd is used on the corn land and the roughage produced is fed to the "cotton farm herd."

The results for the year show a small increase in yield of cotton and an increased average yearly production for the dairy herd. (C. D. Grinnells, R. H. Rogers and W. H. Rankin, Central Station Farm, Raleigh, N. C.)

COTTON INVESTIGATIONS

Cotton Fiber Investigations. In cooperation with the Office of Cotton, Rubber and Other Tropical Plants, of the Bureau of Plant Industry of the U. S. Department of Agriculture, the source and care of cotton-planting seed is being studied on a number of typical North Carolina farms.

The major object of this study is to determine the influence of the source and care of cotton-planting seed on the length of staple produced. As a subordinate object, the effect of the source and care of planting seed on the uniformity of staple and the yield of lint cotton is also being studied.

This project was started in 1930 and results for that year are given in N. C. Station Technical Bulletin No. 42. Studies were made in 1931 and are being continued in 1932. The results obtained in 1931 are similar to those of the 1930 season. The data on file indicate that pure and improved seed stocks are the predominant factor in the production of uniform 15/16 to 1 1/16 inch staple, and that mixed and unimproved seed stocks are largely responsible for the production of staple having poor quality. The results to date also show that improved seed stocks are giving larger yields than the unimproved or mixed stocks.

The relation of purity and care of handling seed stocks to fiber quality and spinning value is being investigated. The object of this problem is to study the relation of changes in standard cotton varieties of known origin and quality to care and handling of seed stocks by farmers and to note the influence of any change on spinning quality. This work was begun in 1930.

Registered seed of the Mexican variety direct from the Station were planted on the farm of W. T. Moss, at Youngsville, in 1931 in comparison with lots of seed of the same variety which had been grown by farmers for periods of two, three and four years and representing good and indifferent handling of seed stocks. Considerable progress has been made in the fiber laboratory and spinning room. The results show that the yarn strength of cotton grown by farmers for four years under indifferent handling decreased 12.5 percent when compared to the yarn strength of cotton grown from the pure original Station seed. The cotton grown from the seed stocks which received poor care also gave more trouble during ring spinning. Yarns made of cotton grown from seed stocks properly handled by farmers for periods of two, three and four years compared favorably with the production from Station seed—the yarn strength had decreased only 5.5 percent. The results thus far indicate that the relation of purity and care of handling of seed stocks to the quality of cotton produced is very important.

Studies, closely related to those just mentioned, are being carried on by the Department to note any internal change in a pure variety of cotton when not allowed to cross with any other variety. This work was begun with the 1931 crop and it is planned to be continued for five or more years.

A study of the physical properties of fibers in several improved cotton varieties and the influence of these properties on yarn manufacture is being made. The main object of this project is to evaluate fiber properties in spinning tests. This work was started in 1932, when nine varieties and strains of cotton were planted at Youngsville and were given similar

cultural treatment. Fiber and spinning tests will be carried on during the year. (J. H. Moore, J. A. Shanklin, and R. T. Stutts).

A Study of Cotton Varieties and Strains with Special Refereuce to New Types and Varieties which may better meet farm requirements. Results on this project, active since 1924, have shown that best yields and usually the highest money values per acre were secured from carefully bred varieties, producing a staple of 1 to 1 1|16 inches. The leading varieties were Cleveland 884, strains 2 and 4; Cleveland 5, strain 5; and Mexican, strains 58, 87 and 128. All of these strains are good yielders, are medium early in maturity and produce a uniform staple of a length which is in greatest demand by the mills. The Foster strains were found to be well adapted to the lower Coastal Plain section of the state. During this year the above varieties have continued to show up well, and Farm Relief, a new variety, is showing considerable promise also.

In the wilt-resistant group, two new varieties, Dixie Triumph No. 25 and Clevewilt have shown much promise in field experiments on wilt infected soils. The Mexican variety also showed considerable resistance to Fusarium wilt. (P. H. Kime).

Cotton Breeding to Meet the Needs of Cotton Farmers and Manufacturers of North Carolina. Pedigreed strains of the Mexican Big Boll variety have been developed and are being grown on three of the Station farms for distribution to cotton growers of the state. These strains have ranked high in the variety tests and the lint has a very high spinning value as shown by recent spinning tests.

During the year a large number of plant selections and strains were grown. Some of these were quite promising in length and uniformity of lint, in yield and other characters. (P. H. Kime).

To Determine Whether Hybrids Between Similar Strains of the Same Variety of Cotton are More Vigorous and Higher Yielders Than the Parent Strains. Crosses between different strains of the Mexican variety were made in 1921. The F_1 was grown in 1930 and the F_2 in 1931. The F_1 plants of some crosses showed some indication of increased fruiting vigor, others of increased growth, and others a decrease in bolls set. The F_2 also showed some hybrid vigor, but very little segregation.

In the F_2 population this year, the plant type of any particular cross was fairly uniform with only an occasional plant showing a slight variation. There was, however, considerable difference found in bolls set and size of plant in the various crosses. Boll size and type was quite uniform within the cross. Distribution of staple length was only slightly more variable than in the parent strains. (P. H. Kime).

The Spacing of Cotton in Relation to Early Fruiting and Yield. In this experiment, started in 1922, data secured over a period of several years show that close spacing of the hills with 2 to three plants to the hill produced heavier yields and also more bolls set during the early part of the blooming period than when wider spacing or fewer plants to the hill were used.

Since starting, the plan of the experiments has been modified to some extent. All of the experiment is planted with a hill drop planter, the hills on the different plats varying from 9 to 24 inches apart. Half of each plat

was thinned to two plants to the hill, and the other half left just as it came up. The unthinned plats averaged between 4 and 5 plants to the hill. The best yields this year were secured where the hills were 9 to 12 inches apart, and the unthinned hills produced as large yields as those thinned to two plants. With 16 to 24 inch spacing between hills, those left unthinned produced larger yields than those thinned to two plants per hill. The results show that farmers may save considerable hoe labor by planting with a hill droper and thinning only those hills containing five or more plants. (P. H. Kime).

Cotton Marketing. The cotton marketing project undertakes to make a comprehensive analysis of the cotton marketing conditions in North Carolina. More specifically the project is designed to: (1) make an estimate of the grade and staple of cotton produced in North Carolina; (2) determine whether cotton is sold on a basis of its grade and staple value on the local markets and whether the prices paid in the central markets are reflected in the local markets; (3) determine how well the type of production in North Carolina is meeting market demands; (4) study local buying methods and practices of gins, time merchants, traveling buyers, mills, etc.; (5) determine the movement of cotton through marketing channels and its cost; and (6) appraise the economic effect of cotton improvement efforts. This project has been active since July 1, 1928.

The study of grade and staple length of North Carolina cotton is carried on annually in cooperation with the Division of Cotton Marketing, Bureau of Agricultural Economics, U. S. Department of Agriculture. This study is designed to furnish data on the quality of cotton produced annually in North Carolina. The grade and staple reports for 40 gins which cooperated in this work for the 1931-32 cotton crop are grouped in Table 4 into the three distinctive cotton producing regions: (1) Tidewater, (2) Upper Coastal Plain, and (3) Piedmont. (A map of these areas was published in the Fifty-third Annual Report, p. 36). In comparison with the data for 1930-31 there was a definite improvement in both grade and staple length, whereas in 1930-31 there was 69 percent of the crop White Middling or better, and 42.5 percent 15/16 inch and over in staple length, in 1931-32 there was 78.42 percent of the crop White Middling or better, and 54.79 percent 15/16 inch and over in staple length. The greatest improvement in both grade and staple length occurred in the Tidewater section. (Compare similar table in Fifty-fourth Annual Report).

TABLE 4.—AVERAGE PERCENTAGES OF GRADES AND STAPLE LENGTHS GINNED IN NORTH CAROLINA BY REGIONS OF THE STATE, 1931-32.

Region	GRADE			STAPLE LENGTH		
	White Middling and Better Percent	White S. L. and Low Middling Percent	Other Grades Percent	15/16" and Over Percent	7/8" and 29/32" Percent	Under 7/8" Percent
I	80.66	17.03	2.31	57.06	42.79	.15
II	77.33	17.33	5.34	54.71	44.00	1.29
III	77.73	10.69	11.58	54.60	44.46	.94
State Average	78 42	14.71	6.87	54.79	44.19	1.02

A bulletin has been prepared entitled, "The Home Market for North Carolina Cotton," which discusses the degree to which North Carolina cotton is satisfying the demand of North Carolina cotton manufacturers. This bulletin is in process of publication. The following conclusions of this study are significant: (1) Although the consumption of cotton exceeds the production of cotton in North Carolina, there is a general out-of-state movement of cotton produced in this state. (2) The out-of-state movement of North Carolina cotton, although rapidly diminishing, can be largely accounted for by shortness of staple length. (3) The improvement in staple length of North Carolina cotton in recent years has resulted in an increased consumption of North Carolina produced cotton. (4) North Carolina cotton farmers can better meet the needs of North Carolina mills by increasing average staple length, developing greater uniformity of staple and grade, and improving grade through better handling practices. (5) The cotton improvement work of such agencies as the North Carolina Agricultural Experiment Station, the Agricultural Extension Service, the Vocational Agricultural Teachers, the North Carolina Crop Improvement Association, and the North Carolina Cotton Growers Cooperative Association is having a good effect and should be furthered as a North Carolina cotton industry program by the cotton manufacturers of North Carolina and all who are interested in the welfare of North Carolina cotton farmers.

A bulletin is also nearing completion entitled, "North Carolina Farm Prices of Cotton in Relation to Grade and Staple Length and Other Factors." The study indicates that farm prices in North Carolina do not reflect premiums and discounts for staple length and grade which obtain in the central markets. There is clear evidence, however, that local markets on which cotton of higher than average grade is sold pay higher average prices. There is less evidence that local markets on which cotton of longer than average staple lengths are sold pay higher average prices. This is an argument in favor of one-variety cotton improvement programs so far as grade is concerned, but it indicates that staple length is not accorded full value in influencing local market prices.

A study of the relation of cotton quality improvement in North Carolina to mill requirements was made by S. L. Clement, Research Assistant. Information was obtained from 53 mills which consumed a total of more than 300,000 bales of cotton during the year ending July 31, 1931. An attempt was made to determine the nature and extent of changes in staple length consumption of these textile mills during recent years. It appears that adverse economic conditions have caused a number of mills to either change the type of product manufactured, or to manufacture additional products. There appeared a tendency to decrease the use of extremely long and extremely short staple lengths and a tendency to increase the use of medium staple lengths. The study indicated that seventy-one percent of the mills replying had preference for cotton from particular localities in the state. Union and Cleveland county cotton was preferred by the largest number of reporting mills. This is of significance since both of these counties have achieved a fairly high degree of standardization. Eighty percent of the cotton mills replying stated that North Carolina cotton can be improved to meet their needs. All except two of

these mills use at present large amounts of out-of-state cotton. The material of this study will be issued in bulletin form during the year ending July 31, 1932.

A study of local cotton buying agencies in North Carolina was conducted during the spring of 1932 by G. R. Smith, joint field representative of the Department of Agricultural Economics, North Carolina State College, and the Division of Cotton Marketing, U. S. Department of Agriculture. This study is based on approximately 300 interviews with such buying agencies as ginners, local buyers and merchants. The following general conclusions are of interest: Gin buying predominates in western Piedmont sections; street buying in Southern Central region; and time merchant buying in Eastern region. The method of sale by farmers was to a large extent, dependent upon farmers' credit relationships with buying agencies. Open competition for cotton on basis of grade and staple length was found in but few of the local markets studied. (J. G. Knapp and G. R. Smith).

Cotton Seed Treatment for the Control of Seedling Diseases. The work on this project for the year herein reported has been directed to (1) the determination of the kinds of species of fungi which cause damping off of cotton seedlings, and (2) to determine the proper amount of dusting material to use in dusting cotton seed before planting. Isolations made from diseased cotton seedlings yielded fungi falling in several form genera. Approximately 70% of the fungi obtained belong to the genus Fusarium, there being at least 5 species represented. Fusarium moniliforme constituted 25% of the total number of individual fungi isolated. Colletotrichum gossypium was represented by 14% of the isolants and Pythium, Penicillium, and forms as yet undetermined by lesser percentages.

Treated and untreated seed were planted in the field on April 19, May 5 and August 10. Commercial dusts containing ethyl mercury chloride and ethyl mercury phosphate increased the stand of seedlings at all dates of planting, the greatest increase occuring in the May 5 test, when conditions, as judged by the behavior of untreated check rows, were most adverse for survival of seed and seedlings. Tests were made using different amounts of dust per bushel. These show that 3 to 4 ounces of dust per bushel of seed should be used when seed is to be planted at a time when it is likely to encounter cold soil conditions. Two ounces per bushel is sufficient when planting is to be made in soil that has become thoroughly warm. (S. G. Leham).

Fertilizer Requirements for Cotton According to Soil Type. Studies of plant nutrient ratios and quantities of complete fertilizer for more efficient production of cotton have been under way for several years. The variety of soil types and cropping systems require that a large part of this work be done with farming communities typical of the major soil types. Each year a summary of previous results are prepared in mimeograph form for the guidance of farmers, county agricultural agents and agricultural teachers. During the past year a portion of this work was supported by a grant from the Educational Bureau of the N. V. Potash My. to study potash requirements of cotton. Similar aid was secured from the Superphosphate Institute for the study of phosphoric acid requirements of cotton

on certain Piedmont and Coastal Plain soils. More complete reports of these studies have been prepared for publication. (C. B. Williams, H. B. Mann and W. H. Rankin).

A Comparison of Different Sources of Nitrogen for Cotton on Field F (Cecil clay loam). This project, started in 1920, has as its objective a comparison of several commonly used sources of nitrogen in a complete fertilizer mixture for cotton.

Highest yields have been obtained in the study of single carriers from nitrate of amonia, nitrate of soda and cottonseed meal. (C. B. Williams, W. H. Rankin and J. W. Hendricks, Piedmont Branch Station).

Efficiency of Different Sources of Nitrogen When Each is Used as the Sole Source in Combination in a Complete Fertilizer on Field A (Cecil sandy loam). The purpose of this experiment is to compare the growth and yield of cotton produced from different individual sources of nitrogen in a complete fertilizer on this type of soil. At the end of five years, the average yields show calcium nitrate and leunasalpeter as larger yielders of seed cotton per acre than the other commonly used materials. The results for 1931 show the same sources of nitrogen leading as in previous years. (C. B. Williams, W. H. Rankin, Central Station).

A Study of Varying Organic and Inorganic Nitrogen Ratios for Cotton on Field W-1 (Cecil sandy loam). Results for the first five years show conclusively that 20 percent of the nitrogen from organic and 80 percent from inorganic sources produced the largest and most profitable yields on this type of soil. (C. B. Williams, W. H. Rankin, Central Station).

Comparison of Sources of Phosphate on Field W-1 (Cecil sandy loam). The object of this experiment is to compare the use of colloidal phosphate and basic slag with superphosphate as sources of phosphoric acid for the growth of cotton on this type of soil. When equal quantities of phosphoric acid from the three sources are compared, superphosphate produced 7 percent more cotton than either of the other sources for the past three years. (C. B. Williams, W. H. Rankin, Central Station).

Concentrated Fertilizers for Cotton. These fertilizer investigations with cotton, started in 1920, are being continued. N. C. Station Bulletin No. 266, published in 1929, gives the results with the use of synthetic nitrogen and concentrated fertilizers on various soil types. Concentrated fertilizers have produced good growth and yields of cotton but, as a whole, have not been altogether as effective as has the use of commercial mixtures made up of the common fertilizing materials. The addition of such minor nutrients as iron, copper, zinc, magnesium and manganese to the mixtures has in many cases improved the efficiency of the fertilizer mixtures. (C. B. Williams, H. B. Mann, in cooperation Bureau of Chemistry and Soils).

Comparison of Methods of Applying Concentrated Fertilizers to Cotton on Cecil Sandy Loam on Field S-3 (Central Farm). The object of this experiment is to determine which of several different methods of applying fertilizers is superior as measured by stand and yield of cotton. The results of four years show that applying fertilizer ten days before planting has given best stand and yields. Applying the fertilizer on the side of the row has given better stands and yields than it did applied in contact or in

close proximity to the seed. The fertilizers made from materials now in common use have produced larger yields than have those made from highly concentrated materials. The difference in yield in favor of the commonly used materials becomes more pronounced each succeeding year the experiment is continued. (C. B. Williams and W. H. Rankin, in cooperation with Bureau of Chemistry and Soils).

Comparative Efficiency of Fertilizer of the Same Nutritive Ratio and Quantity of Plant Food but Differing in Concentration, When Measured by Stand and Yield of Cotton on Cecil Clay Loam (Catawba County). The object of this project is to compare fertilizer mixtures of the same nutritive ratio but of different concentrations and sources of nitrogen, phosphoric acid and potash on the germination and yield of cotton.

It was found that all the concentrated fertilizers used in this test reduced the number of seedlings and final stand more than did the use of ordinary mixtures now in use in the state. The yields, too, from the concentrated fertilizers were generally less than from those mixtures made up with ordinary materials. (C. B. Wiliams and W. H. Rankin, in cooperation with Bureau of Chemistry and Soils).

Cooperative Experiments to Study the Effects Upon Growth and Yield of Cotton of a High Grade Fertilizer Mixture Placed in Different Positions and at Different Distances from the Seed at Planting on Norfolk Sandy Loam (Field P—Upper Coastal Plain Farm). This experiment, begun in 1931, has been made to study the effects of different methods of applying fertilizer upon the germination, stand and yield of cotton. Results thus far obtained have shown great injury to both germination and yield when the fertilizer was applied in contact with the seed. The application of as little as one-eighth of the fertilizer in this manner was very injurious to the cotton seedlings. Applying the fertilizer in a band one inch below the seed have only slightly reduced the injury, while deeper applications gave better results. As a whole, side applications have been more satisfactory both from the standpoint of the stand and yield of cotton than have been applications made directly under the seed. (H. B. Mann, in cooperation with Bureau of Agricultural Engineering, Upper Coastal Plain Station, Rocky Mount, N. C.)

Studies for the Correction of Soil Conditions Causing Black Rust of cotton on Cecil Sandy Loam (Iredell County). The object of this experiment is to determine a control, if possible, for black rust of cotton following after clover crops cut for hay. The results of one year indicate that the use of a high percentage of potash in a complete fertilizer mixture reduces the prevalence of rust, and so far as was observed, it is the only treatment tried out that partially controlled this malady.

Applications of lime, sulphur, magnesium and manganese apparently had no beneficial effects in the first year.

Kainit and muriate of potash gave better control than did the use of sulphate of potash or sulphate of potash-magnesia. This rust did not appear until very late in the season this year, and apparently the damage was not as severe as it had been in previous years. The rust was much more prevalent on the plat that received only phosphoric acid than on any of the other plats of the experiment. (C. B. Williams and W. H. Rankin).

TOBACCO INVESTIGATIONS

Much of the research work conducted in the state is being carried on in cooperation with the Office of Tobacco and Plant Nutrition of the U. S. Department of Agriculture. These investigations with flue cured tobacco were started in 1911 on Durham sandy loam at the Tobacco Branch Station in Granville county, and in 1927 on Norfolk sandy loam at the Upper Coastal Plain Branch Station in Edgecombe county.

The tobacco research work of the year, conducted at the Tobacco Station at Oxford, consists of twelve separate projects, including various fertilizer experiments, variety and disease studies.

Test of Tobacco Varieties. In this test, begun in 1912, between 200 and 300 so-called varieties have been tested, the majority of which have been eliminated for one reason or another after the test of the first year.

Cash, White Stem Orinoco, Bonanza and Jamaica have shown to be the four leading varieties for the middle belt of North Carolina. In experiments conducted at the Upper Coastal Plain Branch Station farm, Virginia Bright and White Stem Orinoco appear to be somewhat better adapted to that section than the Cash variety. Tobacco growers are rapidly becoming conscious of the importance of using better varieties, with the result that there is an increasing demand for pure seed of known varieties of excellent qualities. (E. G. Moss, cooperation Bureau of Plant Industry, Tobacco Branch Station, Oxford, N. C.)

Quantitative Magnesia Tests. The object of this experiment, begun in 1923, is to determine the amount of magnesia required per acre to prevent the development of sand-drown. A series of eleven 1/20 acre plats have been fertilized alike, but magnesium sulphate was applied at different rates so as to give 20, 40, 60 and 80 pounds of magnesia (MgO) in the drill per acre, respectively. On plats receiving 60 and 80 pounds of magnesia the tobacco was retarded in growth in the early stages. Later the tobacco on these plats recovered and made practically the same yield as did those plats receiving lighter applications.

Results secured show that apparently from 20 to 25 pounds of magnesia per acre in the drill will correct the deficiency which causes the sand-drown and that much heavier applications than these of soluble magnesium salts may do harm in retarding growth, especially in the early stages of growth of the tobacco on a sandy soil. (E. G. Moss, cooperation Bureau of Plant Industry, Tobacco Branch Station, Oxford, N. C.)

Tests of Sources of Nitrogen. This experiment, started in 1925, is being conducted to obtain information about the relative value of different nitrogen carriers. The project consists of forty-five 1/40 acre plats in which the different carriers of nitrogen are each used at the rate of 20 and 40 pounds per acre in a complete fertilizer.

Nitrate of soda has thus far given best results of the inorganic sources, while sulphate of ammonia, used with a small quantity of dolomitic limestone, has been almost as satisfactory as the nitrate of soda. Urea has given the best results of the synthetic nitrogen group, while cottonseed meal is apparently the best of the organic group from vegetable sources. (E. G. Moss, cooperation Bureau of Plant Industry, Tobacco Branch Station, Oxford, N. C.)

Fractional Applications of Mixed Fertilizers. This experiment, started in 1931, is being carried on to determine the value of fractional applications of complete fertilizer mixtures as compared to two or three applications of nitrogen alone and nitrogen and potash supplementing the regular fertilizer application, made before transplanting, all of the application bringing the total amount of fertilizer per acre up to standard rates.

Data obtained so far indicate that a split application of the basal fertilizer mixture will generally give better results than is the case when part of the nitrogen is applied at transplanting and the remainder at a second, or at a second and third application. It should be recorded at this point that the seasons of 1931 and 1932 have been very abnormal. A similar series of tests are being carried on at the Upper Coastal Plain Branch Station, near Rocky Mount, and also at the Tobacco Stations at Chatham, Virginia, and at Tifton, Georgia. (E. G. Moss, cooperation Bureau of Plant Industry, Tobacco Branch Station, Oxford, N. C.)

The Study of Black Root Rot *(Thielavia).* This experiment, begun in 1930, has as its object to find a flue-cured variety of tobacco that is resistant to the attack of this disease. About 75 varieties have been tested out to see if any of them have this quality. In addition to testing the varieties, a number of soil treatments have been made in cooperation with Dr. R. F. Poole, of the Department of Botany of this Station.

Two varieties have been found thus far which are showing considerable resistance—Paris Wrapper and Jamaica. Fortunately, both of these are standard flue-curved varieties. Some of the variety selections have been duplicated in Guilford county on the farm of S. E. Boswell, where the best selections have stood up remarkably well against this disease. There will be a small quantity of seed from the Paris Wrapper and Jamaica for a limited distribution for the 1933 crop. (E. G. Moss, cooperation Bureau of Plant Industry, Tobacco Branch Station, Oxford, N. C.)

Studies of Black Shank *(Phytophthora).* This is one of the most dreaded tobacco diseases. It is new in this state and is confined at present to a very small area. In 1931 four acres of land badly infested with the disease were leased and 104 varieties were planted on it with the hope of finding a resistant selection. In addition to this work, a number of soil treatments were carefully made in cooperation with Dr. R. F. Poole, of the Department of Botany of this Station. A few of these varieties have shown some resistance. In the spring of 1932, the selections made in 1931 were planted in addition to five selections which had been made by the Florida Experiment Station. Also, other soil treatments were made in addition to those given the previous year to this badly infected soil.

No positive data have yet been secured, but out of approximately 175 varieties and selections, there are five that are showing considerable resistance. Of these five, most of them are selections which were made by Dr. Tisdale, of the Florida Station. Some of these are cigar type tobaccos, not entirely suitable for flue-cured requirements, but crosses have been made for most resistant flue-cured types. The hybrids secured are to be carefully tested out in 1933. (E. G. Moss, cooperation Bureau of Plant Industry, Tobacco Branch Station, Oxford, N. C.)

A Chemical Control Study of Wilt and Root Rot Diseases of Tomato and Tobacco. This project, begun in 1930, was outlined to determine the effectiveness of certain fungicidal and germicidal chemicals on the organisms that cause root rots and wilts.

The first experiments concerned the treatment of roots and stems of plants during transplanting with various chemicals, especially of sulfur, copper and mercury compounds. None of these tests gave positive results. The root system of the plant was found to be very susceptible to even weak solution of many chemicals. Even weak strengths of the chemicals caused greater damage than the disease did in many instances and without giving adequate control of the causal organism.

An advantageous stimulation of plants on soils infected with *Thelavia basicola*, the causal organism of black root rot, was obtained by pouring around plants either a solution containing one pound of commercial superacid phosphate in a gallon of water or one pound of nitrate of soda in 50 gallons of water. These solutions, being the only ones safely applied to the roots, apparently did not act as disinfectants. They seemed to encourage new root development, which is important, since the activity of the causal fungus was found to be greatest while the soil was cool. Yet during the early period following transplanting, the plant became seriously stunted when there was a lack of good root development.

Soil treatments with various chemicals were started in 1930. The effects of acid and alkaline treatments were given first consideration. Alkaline soils were found to increase the destructiveness of root knot, black root rot, and wilt diseases of tobacco. Acid soils indicated some reduction of the severeness of all of these diseases, and especially black root rot.

During 1932, land which received 400 and 600 pounds of sulfur in 1931 showed a decided control of both *Thielavia basicola*, causal organism of black root rot, and *Bacterium solanacearum*, the causal organism of Granville wilt. The residual effect on *Caconema radicicola*, causal organism of root knot, was not as well marked as had occured on the same plats the previous year. The high soil acidity of pH 3.8 to 4.2 suppressed early growth, which may not permit this method of treatment for practical use, unless the acidity will destroy the organism, and an alkaline material can be used to lower the acidity to the point where normal plant growth will be obtained.

Cooperative studies conducted with the State Department of Agriculture, and the United States Department of Agriculture, on varietal resistance have given some very promising results. The resistance of Paris Wrapper to Black root rot was much greater than that of Cash. Several other selections of tobacco plants highly resistant and very productive on infected soils have been obtained. A number of crosses and strains have been found to be highly resistant to the Black shank causative fungus also. The strains resistance to this disease are mostly of the wrapper types and their practical value will depend upon the results of the further breeding and testing on infected soils. (R. F. Poole).

Studies of Blue Mold. This fungus made its appearance in plant beds of the state in 1931, but did not do much damage that year. In 1932 it spread quite generally over the fluecured belt. A number of different sprays and dusts have been tried out on the young plant-bed seedlings

for the purpose of determining their effects on the plants and in the control of this fungus without any positive beneficial results thus far. (E. G. Moss, cooperation Bureau of Plant Industry, Oxford, N. C.)

Studies of Mosaic and Frenching of Tobacco. This work has been continued during the year in cooperation with Dr. F. A. Wolf of the U. S. Department of Agriculture. Some information has been obtained. A bulletin, embodying the findings on mosaic studies has been prepared for publication and will probably be ready for distribution at an early date. (E. G. Moss, cooperation Bureau of Plant Industry, Oxford, N. C.)

Tobacco Mosaic. Growers of tobacco in this state suffer great depreciation in quality, quantity and value of their crop as a result of the annual recurrence of the mosaic disease. Many of these growers believe that the soil is the chief source from which infection arises. One of the aims in this project has been to measure (1) the extent or degree of soil infestation that results from the production of one or more diseased crops on a given field, and (2) the extent or amount of spread in cultivation and in the operations of topping and suckering.

Tobacco was planted on two plots which had grown 3 successive crops of tobacco having practically 100% of mosaic as the result of artificial inoculation in 1929, 1930, and 1931. In 1932 one percent of the plants on plot 1 and 0.33% on plot 2 developed mosaic presumably as a result of soil infestation. On two similar check plots which had carried crops of mosaic-free tobacco in previous years, an average of 0.32% of the plants developed mosaic. This test, which is now in its third season, indicates that only a very small percentage of tobacco plants become infected with mosaic as a direct result of soil infestation from previous crops. If we may assume that the results would be the same on all soil types, a point which should be tested by direct experimentation, the test indicates also that where high percentages of mosaic are found early in the season, the infection came from sources other than the soil, probably from the hands of workmen in transplanting and worming.

In the test recorded above, the plots were inspected and all mosaic plants were removed before each operation of hoeing or cultivating. Spread of mosaic from plant to plant was effectively checked. In another test in which 5.28% of the plants had the disease as the result of artificial inoculation, the disease was increased to 12% by the first cultivation after inoculation and to 64% by the second cultivation. Moreover, the disease was carried to adjoining rows in which no plants had been artificially inoculated, so that in the fifth row removed one percent of the plants had the disease after one cultivation, and 11.1% after two cultivations. On another plot on which 10.2% of the plants had been artificially inoculated after the last cultivation, the mosaic disease was increased to 62.5% by the single operation of topping in which diseased and healthy plants were handled indiscriminately. On another part of this plot where no diseased plants were handled until after all healthy plants had been topped, the increase of disease was only 1.5%.

These tests show the extent to which the mosaic disease may be spread in the operation incident to tobacco culture. Very few plants become infected as the result of soil contamination. The disease may be effectively held in check by removing all plants which may become diseased previous

to each cultivation and by using care not to spread the virus by indiscriminate handling of diseased and healthy plants. (S. G. Lehman).

SMALL GRAIN INVESTIGATIONS

To Ascertain the Best Varieties of Wheat, Oats, Rye and Barley for Different Sections of the State, and to Isolate New Strains of These Crops Which Are Superior in Yield, Adaptability and Disease Resistance to Varieties Now Being Grown. Results secured in this experiment with wheat since 1922 show that the Fulcaster is the best bearded variety for the state. The highest yielding smooth varieties are Leaps, Gleason, Redhart and Purple Straw. On account of its earliness the Purple Straw variety is better adapted to poor soils than are Leaps, Gleason or Redhart. Reports and observations indicate that the Redhart variety is the best smooth wheat for the Upper Coastal Plain area. Selections of Fulcaster, Leaps, Gleason and Purple Straw are showing considerable promise.

The Fulghum is usually the highest yielding variety of oats during seasons when heavy winter-killing does not occur, but it kills out badly during severe winters. The Lee is quite hardy and a heavy yielder of both seed and forage. The Norton is also quite promising.

Abruzzi rye over a period of five years has averaged 4.5 bushels more seed per acre than the common variety at the Piedmont Station. The yields of seed at the Mountain Station were about the same. The Abruzzi variety is far superior to the common or Rosen varieties for cover crop or grazing purposes in all sections of the state.

The North Carolina, or Rowan barley produces slightly higher yields than has Tennessee Hooded and it is somewhat less susceptible to smut than the latter variety.

New varieties of wheat producing good yields this season were Holden's Improved and Gastra.

Selections from the Lee variety of oats show differences in yield and greater uniformity. New mass hybrids have been grown for three years in order that the less hardy plants may be eliminated by winter-killing.

A Tennessee selection of Abruzzi rye produced higher yields of seed than the North Carolina strain. Selections from North Carolina Abruzzi showed very little difference in yield. Some of these were short awned and some long awned. (P. H. Kime).

To Obtain Varieties or Strains of Wheat which are Resistant to Leaf and Stem Rust, and Are Adapted to North Carolina Conditions. Many varieties and strains from this and other states, and a large number of hybrid selections supplied by the Federal Office of Cereal Investigations have been grown and data secured on yield and rust resistance during the year. The Fulcaster has been found to be the most resistant of the local varieties. Some of the western varieties have shown marked resistance, but they are usually very poor yielders for North Carolina conditions. Those showing most promise are selections from hybrids between Fulcaster and P1068-1 or between these and other varieties and strains.

Rust was unusually heavy during the spring of 1932 and many of the 82 varieties, strains and hybrid selections being studied showed heavy rust

damage. A few were entirely free and some showed light and medium rust injury. A close correlation was noted between high yields and light rust damage. (P. H. Kime and S. G. Lehman).

Wheat Rust. The wheats which are now commonly cultivated in this state are highly susceptible to rust and as a consequence incur large reductions in yield in years of high incidence of rust. This project has for its aim to find or to develop by breeding a strain or variety of wheat which will be more highly resistant to wheat rusts, particularly leaf rust caused by *Puccinia triticina*, and which will yield better than varieties now commonly grown in this state. A number of selections introduced from other areas have been tried and some of these seem highly promising from the standpoint of high rust resistance and good yield. Dr. J. B. Cotner, of the Agronomy Department, has very kindly made a number of hybridizations using the most promising of these selections as one parent with Purple Straw, Leaps and Fulcaster as the other parent. The offspring of these crosses will be grown for observation in 1933, and summers immediately following with the hope that segregates may be found embodying high rust resistance with high yield and good milling qualities. (S. G. Lehman and P. H. Kime).

Barley Seed Treatments. Experience of recent years has indicated that the species of loose smut which commonly occurs on barley in this state cannot be controlled on the Tennessee beardless variety by the use of the usual chemical seed disinfectants. Only the hot water treatment is effective, but considerable injury to the seed occurs when the usual recommendations as to time and temperature are followed. The purpose of this project has been to determine if satisfactory control of loose smut in this variety can be obtained by use of such temperatures or periods of exposure as will cause little or no seed injury. Seed soaked 4 and 5 hours previous to heating were injured much less than seed soaked 7 and 11 hours. The longer periods of presoaking appear to cause greater increase of susceptibility to injury on the part of the seed than on the part of the fungus in the seed. From the consideration of minimum seed injury and maximum smut control, the most satisfactory treatments are (1) presoaking 5 hours and subsequent heating at 126.6° F. (52° C.) for 10 minutes, or (2) presoaking 5 hours and subsequent heating at 129.2° F. (54° C.) for 5 minutes. These treatments completely controlled loose smut, covered smut and stripe. Ceresan (2% ethyl mercury chloride) completely controlled covered smut and left only a trace of the stripe disease. Corona Dust No. 219 and formaldehyde 1-320 were slightly less effective than Ceresan. Two commercial dusts, one containing 2% of ethyl mercury phosphate, the other 2% of ethyl mercury arsenate completely controlled stripe and covered smut, and reduced loose smut to less than half that occuring in the checks. (S. G. Lehman).

Oat Smut Control. Complete control of loose smut of oats was obtained by use of the following preparations: Formaldehyde 1-1 (spray method), formaldehyde 1-320 (Sprinkle method), four percent formaldehyde dust, five percent formaldehyde dust containing 2½% mercury and 2% ethyl mercury chloride. The 42 untreated rows in the test gave an average of 22.9% loose smut. No germination counts were made but head counts

were lower for all treated lots than for untreated lots. Greatest reduction in head count resulted from use of the formaldehyde 1-1 spray. (S. G. Lehman).

Wheat Rosette and Mosaic. Certain areas of wheat land in North Carolina are infested with viruses which cause the diseases known as rosette and mosaic. It has been the object of this project, now in its second year, to find varieties of wheat which are resistant to this disease and will yield well on the infested soils. Seventy-three varieties, selections, and hybrids were planted on diseased soil. Some of these appear to be immune to certain of these disease producing viruses and highly resistant to all of them. Certain selections from Fulcaster, Leap and Nittany appear to offer most promise from the point of view of climatic adaptability, milling qualities and resistance to these virus diseases. These resistant selections should be increased for use on infested soils. (S. G. Lehman).

CORN INVESTIGATIONS

To Determine by Means of Variety Tests, the Best Varieties of Corn for the Different Sections of the State and to Develop Good Strains on Each Experiment Station Farm. Five years' results at the Piedmont Station show Weekly's Improved, Jarvis Golden Prolific and Peak's Single Ear to be the highest yielders. At the Mountain Station the leading varieties were Peak's Single Ear, Holcombe's Prolific, Southern Beauty, Indian Chief and Jarvis' Golden Prolific. Latham's Double has been found to be one of the best adapted corns for the Coastal Plain area. Highland Horsetooth variety has proven the best yielder at the Blackland Branch Station farm. (P. H. Kime).

To Determine the Effect of Intercropping with Soybeans on the Yield and Growth of Corn. Since the beginning of this experiment in 1930, it has been found that the yields of corn are reduced to some extent by intercropping with soybeans, both when planted in the same row with the corn, and when planted in rows between 6-foot corn rows. During dry seasons, the corn yields are reduced to a greater extent, as compared with corn alone, than is the case during seasons when there is a sufficient supply of moisture. The value of the beans harvested or used for pasture will offset to a large extent, the loss in the yield of the corn. In order to get a clear picture of their effects upon the corn, the improvement of the soil through the growth and turning in of the beans must be taken into consideration.

Planting soybeans in corn caused greater reductions in yield during 1931 than in 1930. A higher percentage of nubbins was secured where the corn and beans were planted in the same row than where the corn was planted alone or planted in six-foot rows with a row of beans between each corn row. (P. H. Kime).

A Study of Sources and Rate of Application of Different Forms of Lime for Corn When Used With and Without a Complete Fertilizer (Muck). This experiment was started to compare the efficiency of hydrated lime, marl and ground limestone used on a muck soil. Field experiments have been run continuously since 1917, the results of which are given in a bulletin which is now in the press. Using average corn yields as a measure of efficiency, ground dolomitic limestone ranked first with hy-

drated lime, and marl second and third in value, respectively. Hydrogenion determinations made by the quin-hydrone method have shown practically no differences in the efficiency of these materials in neutralizing the acidity of this soil. (C. B. Williams and W. H. Rankin).

Study of Methods of Culture in Relation to Crop Stand and Yield. (Muck). This experiment, started in 1927, is made to determine the best cultural practices to follow on this soil for corn and soybeans grown in a 2-year rotation. A six year average of the results secured indicates that there is no advantage in rolling or packing this soil after planting the crop. Disking four inches deep before planting has resulted in larger yields than has plowing eight inches deep. Flat cultivation has been found to give better results than has ridge cultivation. (C. B. Williams and W. H. Rankin).

Fertilizer Requirements of Corn on Ashe Loam (Burke County). With the completion of five years' results, it was found that the addition of phosphoric acid gave a larger increase in yield of corn than did additions of either nitrogen or potash. As a matter of fact, the use of potash gave little or no increase. Six hundred pounds per acre of a 12-4-2 mixture produced the largest and most profitable yield. The application of one ton of dolomitic limestone per acre increased the yield 16 percent the first year after its application. (C. B. Williams and W. H. Rankin).

Fertilizer requirements of Corn on Ashe Silty Clay Loam (Avery County). The results of two years' work are very similar to those obtained on Ashe loam in Burke county. The data shows that phosphoric acid is the most important to be added of the three fertilizing constituents, that potash is the least important, and that 400 pounds per acre of a complete fertilizer high in phosphoric acid has produced the most profitable yield of any of the rates tested. (C. B. Williams and W. H. Rankin).

Fertilizer Requirements of Corn on Cecil Clay Loam (Buncombe County). The object of the experiment is to determine whether this type of soil in the Mountain section of the state requires the same fertilization for the most economic production of corn as does Cecil clay loam occuring in the Piedmont section of the state. Two years' results show that 400 pounds per acre of a 12-6-4 mixture has been the leading complete fertilizer. A mixture containing only phosphoric acid and nitrogen (10-6-0), the nitrogen being applied as a side dresing, has given very good yields and deserves further careful trials. (C. B. Williams and W. H. Rankin).

Fertilizer Requirements of Corn on Toxaway Loam (Transylvania County). This experiment has been conducted for three years, each year on a different location. Results thus far secured indicate that 400 pounds per acre in the drill at planting of a 10-3-3 fertilizer is superior to any of the ratios and rates tested. The addition of one ton of limestone per acre had practically no effect on the yield of the corn. (C. B. Williams and W. H. Rankin).

Stored Corn Tests. On August 21, ear corn was dipped in diluted emulsions of five commercial oil emulsions and two home made preparations. They were dried and placed in a wire cage with a corresponding number

of untreated ears. The cage was placed in a corn storage having a large number of rice weevil, and other insects, until late fall when it was removed and placed in a heated basement where it was subject to infestation by Angumois moth and rice weevil. It remained there during the following summer when it was subject to increased numbers of rice weevils breeding in untreated corn, and to other insects, including the cadelle and saw-toothed grain beetle.

After 14 months storage the infested and uninfested grains of each ear were counted. The table below gives the average infestation and the extremes for each kind of oil used. The marked variation in each lot is probably due to increased susceptibility to attack after an initial infestation.

Oil	Dilution	Percent Infested		
		Best	Poorest	Average
1*	1 to 8	1.1	39.	13.7
1	1 to 10	.9	52.	13.3
2	1 to 8	11.	55.	39.1
2	1 to 10	1.8	77.	34.2
3	1 to 8	3.4	53.	22.6
3	1 to 10	11.	65.	29.0
4	1 to 8	4.	70.	19.2
4	1 to 10	4.	81.	35.5
5	1 to 8	5.	51.	21.8
5	1 to 10	1.	35.	16.7
6*	1 to 10	5.7	68.	36.7
7	1 to 8	5.5	67.	30.0
7	1 to 10	2.	56.	21.7
Check		99.	100.	99.7

*Home made emulsions.

The Angumois grain moth feeding on the corn used in these experiments was found to be heavily parasitized by a Chalcidoid parasite, *Habrocytus cerealellae* (Ashm). The life history of this insect was worked out.

At a constant temperature of 30° C. it passes through its life cycle from egg to adult in 12 days, and at 25° C. in 15 days. The pre-oviposition period varied from 1 to 6 days. Adults kept at room temperature and fed sugar syrup varied considerably in length of life and number of eggs laid. The shortest adult period for a female was 20 days, during which 97 eggs were deposited, the longest was 70 days, with a total production of 676 eggs. Eggs of unfertilized females hatch, but produce only males. Fertilized females produce both sexes, but mostly females at first.

The adult female crawls over the corn until it finds a grain in which the Angumois larva has hollowed out a cavity extending to the thin seed coat. The parasite drills through the seed coat with its ovipositor, and probes about in the cavity until it reaches and stings the larva. After the larva becomes paralyzed the parasite forces an egg through the ovipositor and deposits it on the wall of the cavity or on the larva. The larval parasite feeds externally on the host larva. (B. B. Fulton).

FORAGE CROP INVESTIGATIONS

Forage Experiments in Cooperation with Federal Office of Forage Crop Investigations

At Piedmont Branch Stations

To Ascertain Best Varieties, Strains, and Sources of Alfalfa for the Southeastern States. In this experiment, started in 1927, it has been found that seed of the common variety from Dakota, Utah and Kansas are good sources of seed for North Carolina growers of alfalfa. The Grimm variety has been found to be well adapted, too, and produces good yields. Seed brought in from France and Italy have done well so far, but Turkestan, Hairy Peruvian and Arizona strains have not been satisfactory. (P. H. Kime).

To Secure Data on the Adaptability of American Grown and Improved Red Clover Seed and Spring Versus Fall Seeding of Red Clover. Tennessee Anthracnose Resistant red clover seed in this experiment, started in 1929, were found far superior to any of the imported lots, the French seed being the best of this group. Spring seeding was generally found to give better results than did fall seeding. (P. H. Kime).

At Coastal Plain Branch Station

Projects begun in 1931 at this farm deal with the following problems: (1) Tests of different species of crotalaria for soil improvement, (2) Time and rate of seeding crotalaria, (3) The effect of continuous cropping on the growth and yield of seed of crotalaria, (4) Comparison of Austrian peas and hairy vetch in a rotation with corn, and (5) Methods of securing a stand and inoculation of hairy vetch.

Crotalaria spectabilis and striata have been found thus far to be the most promising types for soil-building purposes. Other species have shown some promise for forage. (P. H. Kime).

To Compare New Varieties and Strains of Soybeans With the Standard Approved Varieties Now Being Grown for Hay, Seed and Other Purposes. In this experiment, begun in 1926, at the Coastal Plain Branch Station, the best varieties (1) for hay have been found to be Otootan, Laredo, Nanking and Chiquita; (2) for seed, Tokyo, Herman, Nankin and Mammoth Yellow. At the Piedmont Station, varieties producing (1) the best yields and quality of hay were Laredo, Virginia, Wilson Black and George Washington; and (2) for seed, Herman, Haberlandt, Mansoy and George Washington. (P. H. Kime).

A large number of new varieties and introductions were grown in 1931. Some of these showed considerable promise.

The Production of New Varieties or Strains of Soybeans Which Show Increased Yields or Other Desirable Characters. A yellow seeded Biloxi hybrid has been isolated and is being increased for distribution. It is breeding true for seed and plant characters, is non-shattering and yields slightly more than the original Biloxi.

A number of Mammoth Yellow selections showing less tendency to shatter were grown. Hybrids found in this variety show more promise of non-shattering qualities than do those selections which are typically Mammoth Yellow. (P. H. Kime).

PEANUT INVESTIGATIONS

To Determine the Effect of Selections and Spacing on the Size and Quality of Peanuts, and to Secure Data on the Size, Quality and Market Grades Produced by Different Varieties. In this project, started in 1926, strains have been isolated which show increased yields over the parent stock and larger, more uniform nuts. Some of the strains show a more determinate growth than others.

The best yields and quality combined were secured from the Virginia Bunch variety, with a spacing of eight inches, two plants to the hill; and from the Jumbo (Virginia) Runner, with hills 12 inches apart and 2 plants to the hill.

The average results of the variety tests for the past three years show total yields per acre of nuts as follows:

North Carolina Bunch	1663 lbs.
Virginia Bunch	1597 lbs.
Improved Spanish	1557 lbs.
Jumbo Runner	1520 lbs.

The quality and selling price per pound of the large seeded varieties as contrasted with previous years, was somewhat reversed, being in the following order: Jumbo Runner, Virginia Bunch, and North Carolina Bunch.

Selections from the Virginia Bunch showed total yields ranging from 2040 to 2700 pounds per acre. Total handpicks ranged from 32.4 to 50.5 percent.

The four-inch spacings were found to be too close for both the Virginia Bunch and the Jumbo Runner varieties, the quality being poor and too much top growth. (P. H. Kime).

A Study of the Influence of Certain Dusts and Sprays Upon the Growth and Yield of Peanuts on Norfolk Sandy Loam (Field Studies). Part of this experiment is being conducted at the Upper Coastal Plain Branch Station farm to study certain dusts and sprays with reference to their influence upon the growth, maturity, quality and yield of peanuts. Special treatments with calcium sulphate, sulphur, calcium carbonate, barium carbonate and Bordeaux mixture are applied to fertilized and unfertilized peanuts in a series of field investigations started in 1929. Of these special treatments, calcium sulphate, sulphur and calcium carbonate have, in the order named, been most effective in increasing yields. No difference has been found in the effectiveness of calcium sulphate when applied in the soil before planting or on the foliage at blooming time. Sulphur applied on the foliage at blooming time keeps the plants green late in the fall and retards natural defoliation. It has also consistently increased the percentage of Fancy Hand Picked nuts more than any of the other special treatments.

The average yields of peanuts have been increased by the use of fertilizer, although during dry seasons the stand has been reduced by its use. The 1931 crop of peanuts was well filled. All samples from the fertilized and unfertilized series graded Class A, while in the two previous seasons, the shelling percentages were greater on the unfertilized than on the fertilized series.

This part of the experiment which is designed to determine the effect of application of calcium carbonate, calcium sulphate and sulphur on the nodulation of peanuts under controlled conditions of the greenhouse was started in 1931. Using a virgin Norfolk sandy loam soil with a pH reading of 5.3, the use of calcium carbonate decidedly increased nodulation, calcium sulphate reduced it, and sulphur prohibited all nodule formation. The acidity of the soil was increased by applications of sulphur. Calcium carbonate reduced the acidity, while the use of calcium sulphate influenced it very little. The percentage of total soluble salts in the soil was very greatly increased by applications of sulphur and of calcium sulphate, while calcium carbonate had practically no effect upon it. (H. B. Mann).

Peanut Leafhoppers. Further experiments were conducted to determine the effect of the leafhopper, *Empoasca fabae* on peanuts. Adult leafhoppers were collected on Irish potato and beans and placed in cages containing potted peanut plants. Within one or more days some of the peanut leaves would droop. Some of these affected leaves would recover later, but usually they became completely wilted and died. Other leaves became dead and brown at the tip, while the basal portions remained green. The infested plants made poorer growth than would seem to be accounted for by the loss of foliage. After the infestation increased by the reproduction of the leafhoppers, many of the plants were completely killed. When adult leafhoppers were confined in a small cage on the When confined on part of a leaf, they injured only the part exposed to feeding.

Plants enclosed in cheese cloth cages in the field did not suffer as severely as those in the greenhouse. Plants that were caged on July 13 were measured on August 2. The plants grew vertically in the cages so that height could be taken as an index of growth. In eleven control cages the average height was 20 inches, while in nine cages in which leafhoppers were introduced, the average height was 15.3 inches, although several of these showed little evidence of injury, and few leafhoppers were present when examined. In one cage in which the leafhoppers had reproduced the plant was only twelve inches high and had thirty-two leaves partly or entirely killed.

In the greenhouse, plants sprayed with Bordeaux or dusted with sulphur, previous to the introduction of leafhoppers, made better growth than untreated plants. No such improvement was evident on plants dusted with gypsum. When half of the plants in a pot were sprayed with Bordeaux they averaged slightly better growth than the untreated plants. When infested plants in cages were dusted with sulphur the leafhoppers were killed. This effect was probably aided by the confinement and the hot weather prevailing at the time. It was found that Bordeaux could be made to wet and spread on peanut leaves by adding one part of fish oil to 400 parts of the freshly made Bordeaux.

In the field, rows were given four treatments at about three-week intervals, using sprays of summer oil, nicotine sulphate, two strengths of Bordeaux and dusts of sulphur and gypsum. On account of the unusually dry hot weather leafhopper infestation was reduced, but the row sprayed with 4-6-50 Bordeaux and the sulphur dusted row showed fewer leaves with tip injury than the others. (B. B. Fulton).

Vitamin B Complex in Meals from High-Oil-Bearing Seeds, the Peanut, Cotton Seed, Soybean and Flax Seed. A study of Vitamins B and G in peanut meal made from the Virginia Runner and the Spanish peanut show that each type of meal contains approximately one-sixth as much Vitamin B as a good grade of dried Brewers' yeast (Northwestern). The amount of Vitamin G varies with the samples. Two meals from the Virginia Runner peanut contain approximately one-fourth and one-sixth as much Vitamin G as dried Brewers' yeast. Two meals made from the Spanish peanut are approximately one-fourth and one-eighth as rich in this factor as the dried Brewers' yeast.

Two samples of 36 percent cottonseed meal show about one-fifth and one-eighth as much Vitamin B as dried Brewers' yeast. The assays for Vitamin G are not yet complete.

Published: The Distribution of Vitamin B and its Components in the Peanut, Jour. of Agri. Res., 44: 849, 1932. (F. W. Sherwood and J. O. Halverson).

SWINE INVESTIGATIONS

Quality of Meat. The effect on firmness of body fat of varying amounts of cottonseed meal in a finishing ration for pigs that have been previously fed to definite weights on a ration consisting primarily of shelled peanuts. The project was begun in 1926 and was revised in 1930.

Recent publication of results from this project include one paper before the American Society of Animal Production, 1931, and N. C. Agricultural Experiment Station Technical Bulletin No. 41, issued in September, 1931.

The results to date have indicated that a finishing ration containing 13% cottonseed meal has produced firmer carcasses than a corn-tankage ration.

During the past year pigs receiving a ration containing 25% cottonseed meal did not gain as rapidly as those that were fed lesser amounts of cottonseed meal; the ration containing 25% cottonseed meal did not produce increased firmness of body fat. (Earl H. Hostetler and J. O. Halverson, Swine Research Farm, Raleigh, N. C., In cooperation Bureau of Animal Industry).

Quality of Meat II. To study the quality of pork and feed utilization of pigs that have been (1) Full fed from weaning to slaughter; (2) fed a limited ration to a weight of 100 lbs., then full fed to slaughter, (3) fed a limited ration from weaning to slaughter. Begun in 1930.

A progress report of this work was presented before National Meat Investigations Conference in Chicago, Ill., August, 1932.

Differences in composition and in certain palatability factors of the meat have been apparent in the carcasses of pigs fed by these different methods. e.g. Meat from pigs fed normally from weaning to slaughter weights of 185pounds had a more pronounced aroma, but was less tender than meat from similar pigs fed a limited ration to a weight of 100 pounds, then full fed to slaughter. The meat from pigs that were full fed to 225 pounds, then reduced to 185 pounds at slaughter, had a more pronounced aroma but was less tender and the flavor of both fat and lean was less desirable than in meat from pigs that were slaughtered at a weight of 185 pounds after being fed normally. (Earl H. Hostetler and J. E. Foster, Swine Research Farm, Raleigh, N. C., Cooperation Bureau of Animal Industry).

Pasture for Fattening Pigs. Begun 1927. To determine if pigs grazed on a permanent pasture will consume less concentrates than those in a dry lot when both are full fed the same grain mixture; and will permanent pasture replace 50% of the nitrogenous feeds in the concentrate ration.

Rations of identical composition produced slightly slower gains but were utilized by the pigs approximately as well in a dry lot as on pasture. The pasture did not replace one-half of the nitrogenous feeds in the concentrate ration. (Earl H. Hostetler and R. E. Nance, Swine Research Farm, Raleigh, N. C.)

Comparison of Menhaden Fish Meal with 40% Tankage, as Supplements to Corn for Fattening Pigs, When Each was Mixed with an Equal Amount of Cottonseed Meal. Begun 1931. The pigs receiving fish meal and cottonseed meal required 399 pounds of feed for each 100 pounds of gain, and made an average daily gain of 1.74 pounds, while those receiving 40% tankage and cottonseed meal made an average daily gain of 1.65 lbs. and required 425 pounds of feed to produce 100 pounds gain. (Earl H. Hostetler and J. E. Foster, Blackland Station, Wenona, N. C.)

A Comparison of White versus Yellow Corn for Fattening Fall Farrowed Pigs When a Mixture of Equal Amounts of Fish Meal and Cottonseed Meal was Used as a Protein Supplement. Begun 1929. In previous years yellow corn has produced more rapid gains and less has been required to produce a given amount of gain, than white corn.

During the past year little difference was apparent between the pigs fed yellow corn and those fed white corn. However, in this trial larger pigs were used and more grazing had been available for them than for those in previous feeding trials. (Earl H. Hostetler and J. E. Foster, Blackland Station, Wenona, N. C.)

The Comparative Effects of Feeding a Commercial Mineral Mixture versus a Home Mixed Mineral to Fattening Pigs. Begun 1928. Results from five separate trials have shown rather small differences between pigs fed no mineral, mineral containing dolomitic limestone, mineral containing calcitic limestone, and a commercial mineral mixture. However, slightly more rapid gains were made by the group receiving calcitic limestone.

During the past year seventy-two pound pigs were used. Both groups of pigs receiving the home-mixed mineral mixtures made more rapid gains on less feed than did either the non-mineral group or the group receiving a commercial mineral. (Earl H. Hostetler and R. E. Nance, College).

The Effects of Amount of Salt Used in the Cure and of Length of Time Pork is Left in the Cure, on the Palatability and Desirability of the Meat. Begun 1930. The amount of salt used in the cure had a slightly greater effect on the actual amount of salt in the meat than did the length of time that the meat was left in cure. In every case the judges scored less salty hams and shoulders highest, although this was not the case generally with bacons.

The different cuts of pork, namely, hams, shoulders and sides, vary in the amount of salt that they will take up in a given length of time. The cut, or piece of meat is also apparently a factor in palatability. Hams have shown a higher percent of salt than shoulders, when both were given

the same cure, but under these conditions the shoulders were more objectionable to the judging committee because of saltiness.

In curing bacons the percent of lean present was a greater factor in determining the amount of salt taken up by the meat than was the amount of salt used in the cure, or the length of time it was left in cure. (Earl H. Hostetler and R. E. Nance, College).

BEEF CATTLE INVESTIGATIONS

Relative Efficiency in Production and Quality of Meat of:

(a) Yearlings that have been Produced from Native Cows Bred to a Native Bull.

(b) Yearlings that Have Been Produced from Native Cows Bred to a Pure-bred Hereford Bull.

These studies to be made of the live animals during the growth and fattening periods, of the carcasses at time of slaughter, and of the meat through laboratory cooking and palatability studies. Begun in 1928.

Yearlings from native cows but sired by a Hereford bull, made more rapid gains and required less feed per cwt. gain in the feed lot than yearlings from similar cows but sired by a native bull. They also graded approximately one full grade higher than the native yearlings.

The grade Hereford yearlings made an average daily gain of .44 lbs. greater than the native yearlings, and required 109 lbs. less corn and 105 lbs. less hay to make 100 lbs. of gain. Although the grade Herefords were valued at $.71 more per cwt. at the beginning of the test, only $.30 per cwt. more was required when they were finished in order to break even, due to their cheaper gains ($1.07 per cwt.). They also dressed 1.23% higher than the natives.

As feeders, slaughter cattle, and in the carcass, the grade Herefords graded one whole grade higher than the natives. (Earl H. Hostetler, J. E. Foster and L. I. Case, Blackland Station, Wenona, N. C., cooperation Bureau of Animal Industry).

The Carrying Capacity of Native Reeds (*Arundinaria tecta*). Begun in spring of 1928. The cattle sired by a Hereford bull and out of native cows made more gain on reed pasture from May to November, both as calves and yearlings, than native cattle.

Cows nursing calves while grazing on reeds from May to December, gained back the weight they lost during the calving season from February to May.

During the past year native calves made an average daily gain of .91 lb. on reeds from May 5 to December 31 (240 days), while grade Hereford calves made an average daily gain of 1.02 lbs.

There was no appreciable difference in the gains of the native and grade Hereford yearlings on pastures from May 5 to November 11.

The native cows grazing on reeds from May 5 to December 31 and nursing calves made an average daily gain of one-third pound per head. (Earl H. Hostetler, J. E. Foster, and L. I. Case, Blackland Station, Wenona, N. C., cooperation Bureau of Animal Industry).

The Value of Gleanings from Corn Fields for Wintering Beef Cattle. Begun fall of 1930. Cows and yearlings (past season's spring calves) maintain their weights in the corn stalk and soybean fields from the middle of December to March.

The fields furnished approximately one month's gleaning per cow per acre, or two months' gleaning per 100 bu. yield of corn.

The cows made an average gain of 17 pounds per head while running in the fields from December 31 to February 25. The gleanings furnished feed for 25.4 cow days per acre, or 58.4 cow days per 100 bushels yield of corn.

The yearlings made nearly one pound average daily gain from December 31 to May 17 with only $3.71 per head feed cost in addition to the field gleanings. (Earl H. Hostetler, J. E. Foster and L. I. Case, Blackland Station, Wenona, N. C.)

The carrying Capacity of Various Crops and Farm By-products in Terms of Livestock Units, and The Practicability of Carrying Beef Cattle and Other Livestock as a Part of the Regular Farming Program in Eastern North Carolina. Begun fall of 1930. The first year's work indicated that the stalks of corn yielding 40 to 45 bushels per acre, and soybean stalks from which 15 bushels of beans had been harvested would carry dry cows, yearlings and two year olds in good condition during the greater part of the winter, or 110 days. Requirements, three to four acres per head. On a thousand pound animal basis, six to seven acres per head. Cows nursing calves, heifers close up to calving, cows of excessive ages, and weaned calves under 400 pounds, need supplementary feed.

During the winter of 1931-32, gains were not as good as the previous year. An unusually good pasture season during the summer of 1931, no doubt, accounts for this fact. One hundred days on the stalk fields resulted in an average daily gain of .345. (Earl H. Hostetler and L. I. Case, W. W. Jarvis' Farm, Moyock, N. C., cooperation Bureau of Animal Industry).

Methods of Pasture Development for Beef Cattle and Other Livestock. (a) Methods and Cost of Seedbed Preparation, (b) Adaptation of Various Pasture Grasses, (c) Carrying Capacity of Various Pasture Plants, (d) Fertilization. Begun spring 1930. (a) Careful preparation, breaking, double disking, and harrowing, at an additional cost of $3.25 per acre over disking one way and harrowing, results in no better stand of tame grasses but in a considerably smaller percentage of native grasses.

(b) On lighter soils of the fine sandy loam types, carpet grass, Dallis grass, and lespedeza, do best under rather close grazing while on the black soils, blue grass, Red Top, and lespedeza are best adapted.

(c) During a season of normal rainfall, a good stand of carpet grass and lespedeza, or carpet grass, Dallis grass and lespedeza will, when grazed to capacity, produce about 300 pounds increase in weight per acre during the normal grazing season from May 1 to October 31. The carrying capacity is about 1.8 five hundred pound beef animals per acre.

(d) A complete fertilizer increases the grazing capacity of all improved pasture plants. Phosphate alone increases the growth and spread of lespedeza on fine sandy loam soils, while nitrate alone seems to have the

reverse effect. On black peaty soils potash seems to be the most important fertilizing element for grasses and lespedeza.

(a) Heavy grazing seems to have the effect of gradually decreasing the percentage of native grasses.

(b) Same as conclusions of previous year.

(c) The past season was exceedingly dry and demonstrated the fact that the above pasture mixtures are not dependable. Annual grazing crops should be available for supplementing permanent pastures.

(d) The 1932 season was too dry to make observations of consequence. (L. I. Case, Farms in Eastern North Carolina, cooperation Bureau of Animal Industry).

The Cause and Cure of Emaciation Among Cattle. Begun fall of 1930. The collection and examination of several fecal samples from emaciated cattle showed in every instance common stomach worm (*Haemonchus contortus*) infestation, and in most cases it was quite heavy. Copper sulphate treatment has alleviated the trouble. Furthermore, while no definite work has been done in this line, there is evidence that proper nutrition lessens the debilitating effect of infestation. (L. I. Case, Farms in Eastern North Carolina, cooperation Bureau of Animal Industry).

The Comparative Value of Corn, Wheat and Barley for Fattening Beef Cattle. Begun fall 1931. Three groups of nine steers were fed from November 7 to February 23, or 108 days. Each group received a full feed of corn stover and approximately 3 pounds of cottonseed meal per head daily. One group received ground corn, one ground wheat, and the other ground barley. The average daily gains of these groups were 2.29 pounds, 1.94 pounds, and 2.14 pounds, respectively. There was very little difference in the amounts of corn stover consumed by the different groups. In feed required per cwt. gain 578 pounds of corn, 502 pounds of wheat, and 525 pounds of barley were consumed. The steers in the corn lot showed a little more finish at the close of the feeding trial than those in the other lots. (Earl H. Hostetler and J. E. Foster, Piedmont Station, Statesville, N. C.)

A Study of Vitamin A in Relation to Feeding Cottonseed Meal and Hulls in Larger Amounts to Cattle. Begun January 8, 1930. Previous studies reported in Technical Bulletin No. 39, of this Station have indicated that heavy feeding of cottonseed meal in commonly used rations may result in death or other typical symptons of Vitamin A deficiency in cattle. The present project is designed to study more thoroughly curative and preventive methods for correcting this deficiency.

By the curative method five steers of seven to eight hundred pounds in weight were fed the basal ration of 50% cottonseed meal, 25% each of cottonseed hulls, and beet pulp with minerals supplied. The steers developed Vitamin A deficiency symptons in five and one-half to seven months, and died unless Vitamin A was supplied from some other source.

In 1931-32 the curative and preventive methods were used by feeding eight younger heifer calves of three to four hundred pounds in weight. Two were on the above basal ration, while two were placed on the basal ration in which yellow corn replaced one-half of the cottonseed meal. Four

were fed the basal ration to which cod liver oil was added daily or in which 9.1 percent alfalfa leaf meal was used.

The heifers on the basal and yellow corn rations developed Vitamin A deficiency symptons which were relieved by supplying Vitamin A in cod liver oil. Those fed cod liver oil and alfalfa leaf meal daily in the ration fared better and made consistent gains.

The necessity of supplying some source of Vitamin A to the ration when feeding relatively large amounts of cottonseed meal has been demonstrated by both the supplemental and preventative methods of feeding.

The work completed the past year has shown that cattle on heavy cottonseed meal rations do not develop Vitamin A deficiency symptons when cod liver oil is supplied with the basal ration. After the symptoms have become pronounced, cod liver oil added to the ration has a marked curative effect.

Cottonseed meal can constitute as high as 50 percent of the ration for growing beef cattle and fattening yearlings over a period much longer than is necessary when the ration is adequately supplemented with feeds rich in Vitamin A, such as alfalfa leaf meal and cod liver oil.

In press, A Modified Method for the Estimation of Gossypol in Cottonseed Meal, by J. O. Halverson and F. H. Smith. J. O. Halverson and F. H. Smith, Animal Nutrition. J. E. Foster and Earl H. Hostetler, Animal Husbandry.

SHEEP INVESTIGATIONS

The Practicability of Controlling Stomach Worm Infestation in Lambs by Sanitary Measures. Begun 1929. Lambs provided with temporary pasture made significantly more rapid gains, required fewer days to reach market weight and were more vigorous than lambs drenched on permanent pasture. Stomach worm infestation has been controlled as well by sanitation measures and temporary pastures as by drenching.

Nineteen ewes were started in the Sanitation Group, and nineteen in the Drenched Group on January 4, 1932. When the drenching phase started on May 31, the nineteen lambs in the Drenched Group averaged 53 pounds, and 18 in the Sanitation Group 57 pounds. Five lambs slaughtered from each group on June 1 showed slight infestation of stomach worms, and no significant difference in the degree of infestation in the two groups. From May 31 to June 28 the lambs in the Drenched Group made an average daily gain of .25 pounds, as compared to .35 pounds for the Sanitation Group. (Earl H. Hostetler and J. E. Foster, Central Station Farm, Raleigh, N. C.)

The Effect of Drenching for Stomach Worms on the Growth and General Health of Lambs. Begun 1928. Lambs grazing on permanent pasture throughout the growing season in Piedmont North Carolina must be treated for stomach worms if they are to live and thrive. Drenching should continue from June until frost. Drenching at 14-day intervals was more satisfactory than at 28-day intervals. Drenching without fasting gave just as satisfactory results as with fasting.

Probably the most practical method of control is to change pastures as often as possible and supplement with drenching whenever conditions show that it is necessary.

Lambs drenched at 14-day intervals with fasting from June 10 to October 28 (140 days) made an average daily gain per lamb of .21 pound, while those drenched on pasture made an average daily gain per lamb of .23 pound. There was no noticeable difference in the condition and general health of the two groups, although slightly greater stomach worm infestation was found at the close of the trial in the group drenched on pasture. (E. H. Hostetler and J. E. Foster, Piedmont Station, Statesville, N. C.)

The Improvement of the Eastern North Carolina Native Ewes and Market Lambs in Both Mutton and Wool Producing Qualities. Begun 1928. Lambs produced from native ewes and a purebred Shropshire ram were much blockier and thicker fleshed than their mothers. These half-blood ewes, when mature, were approximately 50% larger than their dams, sheared 138% more wool of better quality, and 49% longer staple, and produced 44% more twins.

Lambs produced from first cross native-Shropshire ewes and a purebred Shropshire ram showed still further improvement over the first cross lambs in type, conformation, and quality, but the degree of improvement is not so pronounced as in the first cross. These three-quarter-blood Shropshire lambs, however, compared favorably with purebred Shropshire lambs, from a market standpoint.

Results of the Past Year:

Average weight of Native ewes at weaning time		70 pounds
Average weight of F 1 Shropshire ewes at weaning time		104 pounds
Average weight of F 1 Hampshire ewes at weaning time		105 pounds
Average weight of F 2 Shropshire lambs at weaning time		59 pounds
Average weight of F 1 Hampshire lambs at weaning time		67 pounds
Average weight of fleece of Native ewes	2.12 lbs.	2.00 in. staple
Average weight of fleece of F 1 Shropshire ewes	4.92 lbs.	2.63 in. staple
Average weight of fleece of F 1 Hampshire ewes	5.17 lbs.	3.42 in. staple

(J. E. Foster and Earl H. Hostetler, Experiment Station Farm).

DAIRY INVESTIGATIONS

Dairy Pasture Studies II. This work was started in 1928 in cooperation with the Synthetic Nitrogen Products Corporation to measure the influence of rate and time of applying fertilizer upon pasture sod and grazing returns. Previous results have shown that fertilization will provide earlier grazing in the spring and later grazing in the fall, thus extending the productive pasture season. These studies were started on two and a half acre plats of hillside land, poor in fertility and organic matter. Untreated plats and plats receiving only phosphoric acid and potash have been used as checks against nitrogen applications. On this phase of Cecil soil complete fertilizer and nitrogen have been essential to sod maintenance and grazing returns. Milk and butterfat yields per acre have increased each year until the past season which was checked by dry weather. During dry seasons the fertilized plats have shown quicker recovery following rain. (C. D. Grinnells, Central Station Farm).

Dairy Pasture Studies III. This study on mountain bottom land is also concerned with pasture fertilization. During the past year plats receiving complete fertilizer have, through extra grazing, produced eighty to one

hundred pounds of butterfat more per acre than the unfertilized plats. (C. D. Grinnells, S. C. Clapp and Harry Coulter, Mountain Branch Station).

Dairy Cattle Pasture Studies III-a. This study conducted in cooperation with dairy farmers of Ashe county is testing the effectiveness of pasture fertilization in reducing the cost of producing milk in typical dairy regions of the mountains. The studies are conducted on one hillside and one bottom land pasture. In spite of the dry seasons and low price of milk, this work has shown promise for dairymen with limited land area. Up to August 28 of the past year, the fertilized pasture on a rather steep hillside showed an increase of 65 pounds of butterfat per acre, and the bottom land pasture 43 pounds above the unfertilized plats. The bottom land pasture was grazed by immature heifers that freshened in poor condition and were fed no supplementary ration. (C. D. Grinnells, Ashe County).

The Value of Lespedeza as a Supplementary Pasture. This is a study of the value of lespedeza as a supplementary pasture. The land allotted to this project is typical of much of the waste land in the state. It has been subject to heavy erosion for a number of years and the soil is low in fertility and organic matter.

During the past year the pasture yields more than paid for the labor and seed costs this year, and there is a very good plant cover left. The improvement made is very marked when one considers the late frost which destroyed a large percentage of plants and the drouth which limited growth and delayed reseeding. (C. D. Grinnells, Central Station. Conducted in cooperation with Dr. A. J. Pieters, Department of Forage Crops and Diseases, U. S. Department of Agriculture).

Relation of Conformation and Anatomy of the Dairy Cow to Her Milk and Butterfat Producing Capacity. Complete data has been recorded on twelve animals during the past year. This study involves the measurements of body conformation and anatomy of cows with records of production. (C. D. Grinnells, F. M. Haig and R. E. Nance, Central Station. Conducted in cooperation with the Bureau of Dairy Industry and fifteen other state experiment stations).

Bovine Infectious Abortion. Results indicate that bovine infectious abortion can be controlled and eradicated by removing reactors, if followed by good sanitation. Of the twenty-five herds included in this study, all have passed one or more negative tests and a number have been certified as "clean herds". (C. D. Grinnells. Conducted in cooperation with Wm. Moore and L. J. Faulhaber, Veterinary Division, N. C. Department of Agriculture and dairymen of the state).

The Comparative Value of Alfalfa and Lespedeza Hay. Feeding trials were continued over three 30-day feeding periods, using the double reversal method with a preliminary feeding period prior to each 30-day period. Thirty-eight cows were used in this study. With the exception of some evidence of a variation in palatability of the two hays as shown by a few animals, the results were fairly uniform.

The data indicated a slight advantage for alfalfa hay over lespedeza hay for dairy cattle. (C. D. Grinnells, Central, Coastal Plain and Mountain Branch Stations).

A Study of Some North Carolina Dairies. This study was made to answer several questions of importance to dairymen regarding production practices and costs. A detailed survey of 32 dairies was made in September, 1931, covering the farm business for the year July 1, 1930, to June 30, 1931. All of the dairymen were Cow Testing Association members, and the production and feed data were obtained from the herd record books. Results have been tabulated showing the size of business, farm income, rate earned on investment, cost per cow, cost per hundred-

TABLE 3.—SUMMARY OF PRODUCTION COSTS OF MILK SOLD.

Farm No.	Net cost of Producing Milk sold	Net cost per cwt.	Net cost per quart Weighted	average price received per qt. or per cwt.
Retailers:	$	$	c	c
2	11,115.96	4.71	11.7	13.9
3	20,635.56	5.72	14.0	18.5
5	13,807.74	6.32	12.7	13.0
7	30,904.11	5 83	13.1	14.8
9	9,569.70	3.87	8.4	10.7
10	43,342.83	4.50	9.5	11.5
11	10,608 16	4.25	9.4	12.8
13	6,334.21	3.33	7.7	12.8
14	1,702.33	2.04	4.4	7.9
15	10,213 03	3.94	8.5	6.9
16	4,747.14	5.65	14.9	16.9
19	8,984.65	4 31	9.7	12.5
22	11,756.07	5.60	13.7	15.7
23	4,544.72	3.43	8.5	12.5
25	2,428.70	3.42	7.6	9.7
29	10,815.70	5.00	10.8	17.3
30	4,916.43	4.17	10 8	15.5
31	40,151.97	7.24	15.9	14.3
32	16,854 38	5.18	13.4	23.3
33	5,776.85	6.30	15.1	14.5
Average	.....	5 03	11.4	13.4
Ave. (excl. #31)		4.77	10.8	13.3
Wholesalers:	$	$		$
4	3,600.72	3.13	.....	4.01
6	26,753.82	6.87		3.12
8	33,941.97	2.86		3.02
12	7,671.20	2.17		3.89
17	3,005.15	3 77		3.49
18	5,711.14	4.42		3.29
20	30,097.67	6.50		4.27
24	2,562.79	2.65		3.76
26	2,283 07	4.15		2.77
27	2,197.57	2 27		3.01
Average	.....	4.54		3.62
Ave. (excel. #6 & 20	.....	2.91		3.54
Mixed:				
1	3,555.52	3.40		3.31
28	6,273.21	3.87		5.83

Note: Farms number 31, 6 and 20 may be termed "show places" and detract from the value of the record when averaged with the genuine commercial dairy.

weight of milk on wholesale producing dairies, and cost per quart on retail producing dairies. Delivery costs and truck costs have also been tabulated for the retail producers. On farms producing for the retail trade, total costs were distributed as follows: Labor, 12.4 percent; feed, 45.6 percent; delivery costs, 24.1 percent; interest and overhead, 9.2 percent; and other costs, 8.7 percent. The value of the feed fed to the producing cows only, amounted to 33.4 percent of the total costs. On farms selling wholesale milk, total costs were distributed as follows: Labor, 15.3 percent; feed, 50.1 percent; delivery costs, 13.6 percent; interest and overhead, 9.8 percent; and other costs, 11.2 percent. Feed for the producing cows alone constituted 36.7 percent of the total costs. A summary of the milk production costs is presented in Table 3. Tables for publication have been completed and most of the written material prepared. It is planned to publish a bulletin on this study as soon as possible. (R. H. Rogers).

POULTRY INVESTIGATIONS

The Effect of Animal Protein Level in Developing Mash on the Growth and Sexual Maturity of Rhode Island Red Pullets. The object of this study is to determine the effect of animal protein level in developing mash on the growth and sexual maturity of pullets. Observations in the state indicate that the developing stage of pullets has been so rapid as to bring the birds into lay at a stage before physical maturity has been attained, thus detracting from the probability of a long, uninterrupted laying season.

This investigation has been conducted during the present year, 1932, and will be continued during the coming year.

One hundred seventy-four nine weeks old Rhode Island Red chicks were divided into two lots of 87 each, the division aiming at equality in size, vigor, and general appearance. Later sexual development proved that nine in the control lot and fifteen in the test lot were cockerels, thus leaving 78 pullets in the control, and 72 pullets in the test lot. From nine weeks of age the group designated as "Control" was fed the developing mash recommended by the State College, this mash containing a total protein content of approximately 17.8 percent, and an animal protein content from three sources of approximately 7.3 percent. The test group was fed a mash containing the same elements, having a total protein content of approximately 16.0 percent and an animal protein content of approximately 5.1 percent.

At the start of the test the control group averaged 1.68 pounds per bird, and the test group 1.73 pounds per bird. Both groups were fed the usual grain ration for developing birds, plus free range with green feed available. The test was continued until both groups were in 25 percent production. The test group was in 25 percent production five days earlier than the control group. The first egg in the control group was laid at the age of 23 weeks and 4 days, while the first egg in the test group was laid at the age of 22 weeks and 3 days. The control group averaged 4.8 pounds at the termination of the experiment, while the test group averaged 4.7 pounds. Egg production for the month during which the test was terminated, was as follows: Control Group—24.9%; Test Group—28.9%. The growth, vigor and color of both groups were approximately the same.

The control group consumed 1,268 pounds of mash and 1,032 pounds of grain, and the test group, 1,210 pounds of mash and 1,207 pounds of grain. Feed consumption per bird in the control lot was as follows: Mash 17.6 pounds, and grain, 14.3 pounds. In the test lot the feed consumption per bird was 15.5 pounds of mash, and 14.3 pounds of grain. The mash and grain cost per bird during the 99 days under test was Control Group $0.47, and Test Group $0.44. (C. O. Bollinger, Coastal Plain Branch Station, Willard, N. C.)

Capon Production. The object of this project is to determine: First, the most economic methods of capon production; second, methods of developing the capons through the period from the time of caponizing to that of fattening; third, the best and most economic methods of marketing the product; fourth, does caponizing present a profitable field either from a strictly commercial standpoint, or as a side line to poultry production as carried on by the North Carolina farmer.

The project was started in the spring of 1931, and has been active since that time.

During the past year approximately 250 capons were developed and marketed from the State Test Farm at Willard, N. C., and the Poultry Plant of the Central Experiment Station, at Raleigh, N. C. Rhode Island Reds and Barred Plymouth Rocks were the breeds used in the experiment. At both Stations an attempt was made to develop the birds on unlimited scratch feed of equal parts of yellow corn and wheat plus free range with an abundance of soybeans, lespedeza and rye grass available. Eight weeks after caponizing, the birds at the Central Station showed unmistakable signs of nutritional deficiency. This same condition appeared in ten weeks time after caponizing at the Willard Test Farm. The condition was quickly corrected by allowing the birds a mash containing three percent animal protein, this being consumed at the rate of two to three ounces per bird per day, thus indicating that a regular supply of animal protein is necessary for the normal development of the capon. During the developing period of seven months, the amount of feed consumed increased as the birds increased in size, and the feed cost per pound gain increased with age, the most economical gains being made during the months immediately after caponizing.

Both ventures proved profitable, the returns on 72 capons and slips marketed at Willard being $61.02 over a feed cost of $63.79. The return on 155 capons and slips marketed at Raleigh was $63.93 over a feed cost of $117.54. The marketing from Raleigh was done by shipping alive 455 pounds of capons and slips to Philadelphia. During shipment these birds lost 51½ pounds, or 11 percent weight. Nineteen percent of the price received was charged to expense. Three hundred eighty-two pounds of capons and slips were shipped live by poultry car. These were fed on the train and lost 52 pounds, or 13 percent weight from time of loading to delivery. By this method of shipment 32 percent of price was charged to expense.

The mortality at Willard was nine in 103 birds caponized, or 8.7 percent, and at Raleigh six of 161 birds, or 3.7 percent.

The project is being continued during the present year, and results published in bulletin during the present year. (N. W. Williams and C. O. Bollinger).

Pathological Hematology of the Fowl. This project has been under investigation for the past fiscal year. It has as its objective the establishing of blood change in the fowl under disease conditions. The problem is basic in importance in that a knowledge of such blood changes is essential for a thorough understanding of poultry disease process. During the past year a thorough study has been conducted on the blood changes occurring in avian typhoid, a disease which is particularly prevalent in North Carolina.

Prior to studying the abnormal conditions, the following results were secured on twenty-nine blood counts from apparently normal birds:

Elements	Studies Conducted	Range of Differential Readings	Average Established
Heterophils	65%	39-55%	46.54%
Basophils	82%	0-5%	3.23%
Eosinophils	85%	0-5%	2.00%
S. Lymphocytes	57%	21-35%	27.25%
I. Lymphocytes	87%	0-10%	4.60%
L. Lymphocytes	100%	0-5%	0.875%
Monocytes	75%	6-20%	12.45%
		Numerical Readings	
Erythrocytes	66%	2,360,000-2,960,000	2,650,000
Leucocytes	96%	7,000-40,000	18,300

In typhoid, as the toxemia progresses, changes occur in the blood picture. The numerical and differential counts show specific tendencies to vary from the normal averages established in the studies on normal birds. The leucocytes make a decided numerical increase, showing a shift to the right of the normal. The lymphocytes show a shift to the left, almost disappearing in some cases. The heterophils and the monocytes make absolute and relative increases in their counts. The monocytes show a greater difference between the normal average and the pathologic average established in those studies than is shown by the heterophils.

The erythrocytes and hemoglobin show definite changes in some acute cases of avian typhoid. The general tendency of the erythrocytes is to decrease in number. The hemoglobin also shows a definite shift to the left, but the decreases do not always parallel the decreases made by the red cells. The hemoglobin may sometimes show an increase in amount when the red cells show a numerical decrease. Oligochromemia, scantiness of hemoglobin in the red cells, may be found in rare instances. Oligocythemia, deficiency in red cells, is definitely shown in two cases.

Routine blood studies have also been conducted on birds showing other pathological conditions, but not in sufficient number to warrant their presentation. In all cases the supravital method of study was used. A technical bulletin on this project is in preparation. (R. S. Dearstyne, F. W. Cook, J. E. Kelly).

Investigation of Septicemic Diseases Among Fowls in North Carolina. The specific phase of this problem, conducted during the past year, involved the investigation of results of different methods of immunizing birds against avian typhoid.

The project has been active in its various phases for the past five years. A technical bulletin on this subject is ready for publication at the present time.

The general conclusions of the study are summarized as follows:

1. In these studies it is apparent that the success in vaccinating birds against avian typhoid will largely rest on securing proven antigenic strains for the bacterin. Apparently, the polyvalent bacterin for general issues gives a greater chance of immunization than that of monovalent character.
2. No differences could be noted in the response to vaccination or in susceptibility to the disease of males as compared to that of females.
3. The response to vaccination during the first three days after vaccination is rapid, but immunity developed is not sufficient to resist infection should sufficient number of virulent organisms be ingested during that period. The likelihood of such liberal ingestion under field conditions, however, is remote, and the early immunity so developed should suffice to prevent infection by contact or from infected soil and utensils.
4. The peak of agglutinin production brought about by the single vaccination occurs between the 7th and 14th days, probably about the 9th or 10th day. In these studies the serum titer of all vaccinated birds dropped to normal by the 49th day after vaccination, 94 percent of the 18 birds studied being normal by the 30th day.
5. The one week interval between vaccinations of birds apparently is too short to obtain a maximum of benefit from an immunilogical standpoint. Field studies indicate a three-month interval can be adopted with a reasonable assurance of eliminating the infection in ranging birds. Three vaccinations are indicated.
6. Despite some variations in the response to artificial infection of individuals vaccinated, the general tendency shows a gradual diminishing of resistance according to the time interval between vaccination and infection. It is hardly conceivable that the resistance built by vaccination will encounter under field conditions such a severe test as brought about by artificial infection and, apparently, the resistance built up by vaccination, either with the single, double or triple system, should protect birds on infected range against the disease for at least ninety days. This is borne out by results obtained in field outbreaks.
7. The response of fowl to vaccination parallels, in general, that of man and of laboratory animals.
8. Ingestion of live causative organisms of fowl typhoid following vaccination has a tendency to develop a high and long standing immunity. This may be in the form of demonstratable agglutinins for a period of as long as twenty-four weeks after the said ingestion.

Further studies than those listed in the above summary are being conducted on range infection. Both vaccinated and unvaccinated birds are at present on known infected range. Carriers of pullorum disease are also included to test whether or not the antibody present yill protect against natural infection with typhoid. This study is of the "long time" type. (R. S. Dearstyne and R. E. Greaves).

Investigation of Septicemic Diseases Among Fowls in North Carolina. The specific phase reported is the continuation of study of the intermittent reactor to the test for pullorum disease.

The project has been active for eight years, four technical bulletins having been published on the subject.

During the past year studies have been continued in the semi-monthly serological test of carrier birds. A number of these birds have been under test for five years. Present indications point toward the intermittent reactor becoming a constant reactor after several years of intermittent tests. (R. S. Dearstyne and R. E. Greaves).

The effect of feeding of fermented mash on egg production. To measure the value of fermented mash (yeast) to increase and to maintain high egg production.

This project was started September 17, 1932, the tests being run at the Coastal Experiment Station, Willard, N. C. In each pen of the test 150 Single Comb Rhode Island Reds were used, there being 114 pullets and 36 hens of as near equal age, breeding, and vitality as could be selected. Pen 1 was used as the control lot, and Pen 2 given fermented mash. Housing, grazing, and feeding conditions were approximately equal. In making fermented mash two to three cakes of yeast were used twice a week as a fresh starter. This yeast was added to a ten quart bucket of dry mash, which was moistened and allowed to ferment from twenty to twenty-two hours. The birds were fed the amount of mash they would consume in thirty minutes.

The results secured on this test show the production of the control lot to be 15,885, or 1,323¾ dozen eggs, and production of the test lot to be 18,396, or 1,533 dozen eggs, the test pen laying 2,511 more eggs than the control pen. Feed consumption in the control lot was less than in the test, there being consumed 5,476 pounds of mash, and 5,677 pounds of grain, while the test lot consumed 6,319 pounds of mash, and 5,993 pounds of grain. Both pens utilized approximately 180 pounds of oyster shell during the period of test.

Due to higher protein in the test lot, the feed cost of producing a dozen eggs was $0.119, while in the control pen the feed cost was $0.12 per dozen. There was a difference of value of eggs produced of $20.36 in favor of the test lot during the year. Mortality was six birds less in the test pen than in the control pen, and on finishing the test the birds in the test pen were heavier, of better color, and apparently higher in vigor than the birds in the control pen. (C. O. Bollinger).

Vitamin D Study of Menhaden Fish Oil. A preliminary series with chicks has been done, using the basal ration of A. D. Holmes and M. G. Pigott (Journ. of Ind. & Eng. Chem., 23, No. 2, 1931, p. 190) which ration contained alfalfa leaf meal. The results of calcification for the lot of chicks fed the basal ration alone and for the different lots of chicks whose rations were supplemented with sources of Vitamin D did not show wide enough differences to be outstanding, possibly due to the alfalfa lead meal which the ration contained. A basal ration recommended by Hart, of Wisconsin, which produces severe rickets, will be used. (J. O. Halverson and R. S. Dearstyne, in cooperation with Poultry Department).

BEE INVESTIGATIONS

Wintering of Bees. New information secured from additional data seem to justify the continuance of this project.

Data for the current year has not been completely analyzed, but some outstanding facts are present. The winter of 1931-32 was far from the average as the fall was extremely mild and most of the low temperatures were recorded in late winter or early spring. The bees consumed more food this winter than during other winters. They were active during the fall, using large amounts of food, then spring brood-rearing plus low temperatures encouraged extra feeding.

We have data to show just how many adult bees die during the winter period. Some colonies are wintered without a queen, and loss in weight can be correlated with the number of bees. In some cases 9 ounces represented the adult bees dying during the winter.

During this winter period ten colonies were used in the experiment. Two were unprotected, two had paper protection, three were packed in cases, and three were protected in the double-walled hive.

The cold spring seemed to retard brood-rearing and rapid building up of the colonies. Indications are that the most desirable ways to give added protection to colonies of bees in this locality are by using the double-walled hive first, and next by using the regular four-colony packing case.

Rapid building up is used as an index to honey storing capacity. (F. B. Meacham).

A Survey of the Honey Producing Plants of the State. A progress report was given of this project before the N. C. Academy of Science in the form of a paper, In this report a bibliography was given:

> The importance of honey plants to the beekeeping industry.
> A good list of honey plants of North Carolina, and the correlation of the scale hive with honey produced and the flowers furnishing it.

The data accumulated from over the state during this period was a limited amount.

Special emphasis was placed on the project as it applied to Piedmont North Carolina, and the locality in Wake county. The scale hive record was kept for a longer period than usual. From this record we learn that the honey flow was not nearly as good as in the previous year. The time of greatest yield was about the same, being from April 20 to May 20, and during this time over 80% of the surplus honey was secured.

The following plants are credited with a large part of the surplus spring honey flow by several individual reports:

Black locust	April 27 to May 7
Vetch	April 5 to June 13
Dewberry	April 23 to May 15
Tulip tree	April 20 to May 24
Blackberry	April 30 to May 19
Privet Hedge	May 5 to May 31
Crimson Clover	April 24 to May 9
Alsike Clover	April 4 to July 15
White Clover	April 14 to July 25
Persimmon	May 24 to June 5

From present results it seems necessary to continue this project. Our list of plants that bees have been noted working for nectar or pollen, is

now one hundred. From this survey it is hoped to obtain information on why honey plants vary so much in their yield from year to year (F. B. Meacham).

The Bees of North Carolina. Some additional material has been collected for study, principally in the vicinity of Raleigh, but at the present time the principal activity is the building up of a bibliography to make possible the determination of those species of bees which have been previously described. Some of the literature is not readily available, but a comprehensive bibliography is being gradually accumulated by means of photographic copies. A large proportion of the total list of references which it is necessary to obtain can be found in the libraries of this and neighboring institutions, but to complete the work will probably necessitate visiting some of the more comprehensive libraries in Washington, or other large centers. (T. B. Mitchell).

FRUIT AND NUT INVESTIGATIONS

Peach Orchard Management. For a number of years a study has been made of a number of representative peach orchards located in the Sandhills of North Carolina. The major objectives of this study are (1) to determine the reaction of growers to the changes in price of peaches, and other competing crops; (2) to determine the volume of capital necessary to successfully conduct the peach production and the risks involved; and (3) the possibility of selecting supplementary and complementary enterprises to peaches. The results of this project will not be published for a number of years. However, it is planned to issue a mimeographed report covering the first five years of this investigation. The first year of this investigation has been published in the Tax Report, issued in 1928. It is also found in Bulletin 267, of this Station, entitled "Farm Income and Taxation in North Carolina." (R. H. Rogers).

Peach Fertilizer Studies. In 1929 differential nitrogen fertilization was started on an eight acre plot of bearing Elberta peach trees in the Sandhills section. The object was to study the influence of the time and rate of nitrogen fertilization on the growth and yield in relation to the carbohydrate and nitrogen reserves of the tree. A report of the growth and yield of these trees for the first two years was presented at the annual meeting of the American Society of Horticultural Science.

The 1932 yields of each treatment were about six percent below those of 1931. Again this year a total annual application of 3 pounds of nitrate gave yields fifteen percent above a 1½ pound application and almost equal to 6 pounds (166, 165, 142 pounds of fruit for 6, 3, 1½ pounds nitrate, respectively). However, this year yields were greater where one of the fertilizer applications was made after harvest in contrast with yields in, 1931, which were higher with early applications. This is in part due to the dry seasons, but emphasizes the importance of available nitrogen early in the spring, either from early spring applications but preferably from elaborated materials stored in the tree. It is important to consider two factors in relation to the yields from these plots; first, the winter cover crop of vetch, which is equivalent to a nitrogen fertilization; and second, the fact that relatively heavy thinning has been practiced, which has had atendency to reduce all yields to the same level.

Two reports of the physiological studies were made during the past year; seasonal variation in the nitrogen reserves at the American Society of Horticultural Science, and effect of nitrogen fertilization to dormant trees at the North Carolina Academy of Science.

Data for the past year on the food reserves of the tree agrees closely with what has been previously reported. Due to the dry season in 1932 the effect of nitrogen fertilization on the percentage of total nitrogen of the shoots was delayed from three to four weeks after application. Nitrate applied after the first killing frost (December 3,) and in early spring (March 15), did not influence total nitrogen concentration in shoots by April 15, as compared with check treatments. However, on May 15 almost equal response in total nitrogen in shoots was found from equal applications made at either time. Studies with trees in pots kept in storage at different temperatures indicated that nitrogen was absorbed by the roots of temperatures were above freezing, but that translocation to tops did not occur unless the temperature was 45° F. or above. Due to the dry season, measurements of tagged terminals gave only minor differences in period and rate of growth between different fertilizer treatments.

Application of equivalent amounts of nitrate of soda and sulphate of ammonia produced similar response in total nitrogen of shoots on May 15, while cyanamid and cottonseed meal were equivalent to only half the amount of nitrate of soda. Average tree yields for the different treatments were; nitrate 172 pounds of fruit, sulphate 134 pounds, cottonseed meal 137 pounds, and cyanamid 119 pounds. As this was the first year of treatment to uniform trees, it is possible that differences in yield were in part due to differences in availability of nitrogen during the setting of fruit. One month after application sulphate had increased the soil acidity 1.0 pH, as compared with nitrate, and during the remainder of the season gave soil pH readings 0.2 to 0.7 lower than nitrate. Cyanamid caused severe foliage burn in July, three months after application which continued to develop throughout the summer. Data for defoliation experiments in 1931 indicate that defoliation in June reduced the growth of the terminal proportional to the severity of the treatment, and inhibited fruit bud formation especially on the part defoliated. Defoliation in July and August had little effect on growth or fruit bud formation. Data for 1932 is not yet complete. (C. F. Williams).

Leaf Area Studies. The purpose of this project, which has been active for two years, is to study the relation of leaf area and efficiency upon the development and quality of peach fruits and upon the growth of the peach tree. A part of the results of this project was published in the 1931 Proceedings of the American Society for Horticultural Science. General conclusions of the project to date are: That within limits an increase in relative leaf area per fruit favors an increase in size of fruit and an improved flavor as measured by acid and sugar content of the fruit, and that the minimum leaf area which favors the production of quality fruit varies markedly with different soil moisture conditions.

The results of the past year may be summarized as follows: (1) The proposed soil treatments were quite successful in maintaining significant difference in soil moisture. (2) Reduction of soil moisture under relatively constant atmospheric conditions is reflected in tree behavior by shortening of the period during which the stomata are open, and accord-

ingly functioning in food elaboration. (3) Fruit borne on trees growing under distinctly different soil moisture conditions was correspondingly different in size, despite the fact that the leaf to fruit ratios were the same. Increase in moisture supply favored formation of fruit of increased size. (4) Increase in leaf to fruit ratios on ringed branches resulted in the formation of increasingly larger fruits, and to a limited extent in the hastening of fruit development and ripening. (Ivan D. Jones).

Peach Fertilization in the Piedmont. This orchard was planted in the spring of 1931 at the Piedmont Station to study tree response in relation to soil management on heavy clay soils. To date soil management has been uniform for all trees and has consisted in the application of nitrate of soda and the growing of a summer crop of soybeans and a winter cover of wheat and vetch, both of which have been disced in. Special attention has been given to the formation of strong trees by careful attention to pruning. Height of head has been regulated in order to facilitate trunk measurements. Differential treatments will be begun in the spring of 1933. (M. E. Gardner).

To Study the Effect of Heavy, Medium and Light Pruning on Growth and Production of Peach Trees under Piedmont Conditions. This project has been active since 1923 and some general conclusions from the work reported last year. During the past year the project has been conducted as outlined in previous reports and the results have been in accord with other years. The orchard has passed through ten growing seasons, seven of them being crop years, and it is felt that the objective has been reached. It, therefore, seems desirable to discontinue the project as outlined and utilize the trees for other studies after the 1932 growing season. (M. E. Gardner).

The Peach Bacterial Spot. This project was started during 1929. The objects were to determine, where the causal organism lives over, how it is spread, varietal relations, relations of fertilization to disease development, if other diseases make the tree more susceptible, relation of soil type to severeness of the disease, cultural developments of *Bacterium pruni*, the causal organism in various chemicals, and finally the beneficial control effects of germicidal chemicals sprayed on the tree.

The organism was found living over in cankers of plums, especially wild plums and cultivated varieties, such as Burbank, and Abundance varieties, and in cankers on the peach. It spreads in all directions, but mostly with prevailing winds from south-west. Georgia Bell variety is found to be highly resistant, the Hiley Bell Variety is slightly more susceptible, the Elberta variety is susceptible and the Hale variety is very susceptible. Good fertilization has suppressed defoliation where infection was heavy, but has not influenced the degree of infection of either leaf or peach. Live-over cankers were greatest on well fertilized trees.

Hale and Elberta trees sprayed with various concentrations of lime, sulfur, colloidal calomel, cresol, phenol, potassium permanganate, colloidal copper and zinc sulphate with lime spreaders added to all spray solutions have shown some reduction in infection where any one of these were applied. The cresol, phenol, potassium permanganate, and colloidal copper

compounds gave promising control, but when used with the usual amount of lead arsenate necessary for insect control all of these chemicals caused heavy defoliation and leaf spotting. All of these definitely stimulated arsenate injury. High grade chemical hydrated lime used alone at the rate of 50 pounds in 50 gallons of water has given promising control, although the heavy deposit left on the fruit at harvest is undesirable.

The spotting of foliage and cankering of twigs due to arsenate compounds are somewhat similar in character to those caused by the bacterial disease. Control of the arsenate injury is important, and demands consideration, while the control of the bacterial disease is being studied. Certain of the germicides, including zinc sulfate, flotation sulfur, colloidal sulfur, and chemical limes have greatly suppressed arsenate injury. The results to date indicate that the use of four pounds of zinc sulfate and 8 pounds of chemical hydrated lime in 50 gallons of water in which one pound of arsenate of lead is added gives a much safer spray than one that does not contain the zinc sulfate. The results also clearly show that the chemical hydrated limes are safer than the coarse ones when used with acid lead arsenate. Tests with basic lead arsenate have also given promising control of arsenate injury.

Trees sprayed with the lime at the rate of 50 pounds in 50 gallons of water, zinc sulfate and lime up to 12 pounds each in 50 gallons of water, and colloidal sulfur up to 10 pounds in 50 gallons of water have shown greater retaining of foliage on trees late in the season. The reasons are not clearly understood. (R. F. Poole).

Late Infection of Peach Leaf Curl in North Carolina.

Plant Disease Reporter, Vol. XVI. No. 16, pp 171-172. Nov. 1932.

Apple Pruning. Outlined in 1919 to determine the effect of the amount of annual pruning on tree performance and to study and contrast the open center and modified leader methods of training on high and low headed trees.

General conclusions to date may be summarized as follows: (1) Lightly pruned trees have given highest total yields. (2) Low hanging limbs on lightly pruned trees headed 24 inches are objectionable both from the standpoint of cultivation and picking. (3) Indications point to a preference for trees headed 36 inches and trained according to the modified leader method. (4) It is believed that the medium pruning treatment is the most desirable.

Winesaps were graded again and the percentage of fruit below two and one-quarter inches was even greater than reported last year. This condition was due to insufficient moisture. All varieties should be graded next year if conditions are favorable for a normal crop. (M. E. Gardner).

Fruit Variety Tests. (1) To study varietal adaptation of new and noteworthy fruits to the varied soil and climatic conditions existing in the state.

(2) As a source of breeding material.—Active since 1928.

Additions to the tests have brought the total to approximately 229 varieties. As previously outlined, the test includes apples, peaches, cherries, small fruits and grapes, and Foreign Plant Introductions. Systematic records are kept each year and some very interesting differences have been noted between varieties of small fruits and grapes grown at the

Central, Piedmont and Mountain Stations. This work is proving to be a valuable source of information in recommending varieties for commercial planting and selecting those varieties best adapted for further experimental study. (M. E. Gardner, J. G. Weaver).

Pecan Cracking Test. A study of the internal and external characteristics of twenty-four varieties of pecans was conducted over a twelve-year period. The data have been summarized and presented at the 1931 meeting of the American Society for Horticultural Science.

It was found that percent of meat varied greatly between varieties and with the same variety in different years. No correlation was found between percent of meat and precipitation for the months of August, September and October, or of percent meat between varieties. (M. E. Gardner).

Tree Performance of Bearing Pecans. Trees planted at the Upper and Lower Coastal Plain Stations during the winter of 1906-1907 were all bearing in 1915. Annual yield records of individual trees have been taken since that time and were summarized and reported on last year. The average annual yields per tree over the 17 year period are surprisingly low. At the Lower Coastal Plain Station the average annual yield per tree of Alley, Schley, Stuart, Van Deman and Money Maker varieties was 8.41 pounds, and at the Upper Coastal Plain Station, 8.58 pounds. The Van Deman variety gave the lowest yields, and Money Maker the highest yields. A 16-year summary of the above yield records was given before the Southern Agricultural Workers in 1931 in a paper on the performance records of pecan varieties in North Carolina. A similar paper which also included records for the year 1931 was given before the American Society for Horticultural Science in December 1931. A paper on pecan investigations in North Carolina was read before the National Pecan Association in September, 1932. (R. Schmidt, M. E. Gardner).

Orchard Management of Pecans. In 1927 three blocks were laid out in the pecan grove at the Upper Coastal Plain Station—one receiving clean culture the entire year, one having a cover crop of rye planted in the fall and plowed under in spring, and the third block remaining in sod. Each block included trees of three varieties, viz., Van Deman, Schley and Stuart. It was thought possible that cultural treatments would have some effect on the biennial bearing habit of pecans. The crop years have been too few to make any definite deductions, but for the year 1931, which was a very dry season, the yields were decidedly better on the cultivated blocks, especially for the Schley variety. The results indicate that in a dry season the sod will use up moisture necessary for the pecan crop. (R. Schmidt).

Pecan Breeding. In 1915 almost 500 pecan seedlings of known parentage were planted at the Lower Coastal Plain Station for the purpose of developing new varieties especially suited to North Carolina conditions. On account of close planting and poor soil conditions, the seedlings have been slow in coming to bearing. As each tree produces nuts, these are examined and if they are not found worthy, the trees are removed. Up to the present time, 3 seedlings have been selected as showing exceptional qualities. (R. Schmidt).

Strawberry Fertilizer Project. This work has been carried on at Mount Olive, N. C., on the Albritton farm since 1930, in order to determine, if possible, the best dates for the application of fertilizer on strawberries, and the best combinations to be used. The summers of 1930 and 1931 were exceptionally dry, causing the results on time of application to be somewhat inconsistent, although the August 1st—December 1st, and August 1st—January 1st applications were above the average. 1000 pounds of Standard 8-4-4 (P-N-K) fertilizer applied July 1st and 250 pounds of fish meal applied November 1st and February 1st respectively, gave good yields. This was also true of an August 1st application of 1000 pounds per acre of an 8-4-4 (P-N-K) standard fertilizer and 500 pounds of fish meal on November 1st. A fertilizer mixture containing half the nitrogen from fish meal, one-fourth from nitrate of soda, and one-fourth from sulphate of ammonia was used as a standard mixture in these tests and gave better results than when all the nitrogen was derived from sulphate of ammonia or nitrate of soda alone. The insignificant effect of varying the phosphoric content indicates that phosphoric acid is not an important factor in strawberry production. Increased potash content of the fertilizer mixtures seemed to depress yields. Nitrate of soda gave slightly better results than sulphate of ammonia, probably because of the fact that the soil in the plots was very acid. The Klondike variety was used in these tests. A paper on Strawberry Fertilizer Investigations was presented before the Southern Agricultural Workers in February, 1932. (R. Schmidt).

A Study of Soil Conditions in the Chadbourn Area that Have Been Unfavorable to Strawberry Production (Columbus County). Investigations with strawberries to study those soil conditions which have been unfavorable to strawberry production were started in 1929. A preliminary report covering the work for the seasons of 1929-30 and 1930-31 is given in Agronomy Information Circular No. 64 of this Station. Another report covering the work to date is now in the press and will be available soon.

The 1931-32 season was very dry during certain parts of the year, and many of the strawberry plants died in the field. This dying was most severe on the very acid soils, likewise the dying was more extensive in fields that had been fertilized with high amounts of sulphate of ammonia than those fertilized with equivalent amounts of nitrate of soda.

The fertilizer which has been found to give best results is one containing 8 percent available phosphoric acid, 6 percent ammonia, and 6 percent potash used at the rate of about 1500 pounds per acre.

Instead of splitting and applying one-half of the fertilizer in the spring and the other half in the winter to the strawberries, as is quite commonly done, it was found that best results follow applying all of the fertilizer in late summer or early fall. (H. B. Mann, cooperation Bureau of Chemistry and Soils).

Response of Strawberry Plants to Varying Amounts of Lime. This project was begun in the spring of 1932 with the following objectives: (1) determination of amount of lime necessary to change the pH of a soil high in organic matter; (2) effect of lime on growth and stand of strawberry plants; and (3) varietal response of plants to varying amounts of lime and resultant soil reactions. Work has not progressed far enough to

report results or tendencies. There is definite need for work of this nature, as many fields of strawberry plants have died out due to supposedly too acid soils. The work is being conducted on the farm of Mr. J. T. Albritton. (E. B. Morrow).

Dewberry Fertilization and Pruning. A study of food storage on the dewberry as influenced by pruning and fertilization treatments and its relation to growth and fruit production was started in 1925.

Such severe injury from various diseases has been experienced on all experimental plots that satisfactory results have been difficult to secure. During the course of the pruning studies a satisfactory control for one of the most serious cane diseases was found. A study of the various degrees of pruning in relation to the control of Coniothyrium cane blight has been reported in a bulletin of this Station. Pruning off all canes immediately after harvest at or just below the surface of the ground has given satisfactory control of the Coniothyrium cane blight disease; for this reason and because of practical vineyard management this method of pruning has also given the best results in cane growth and yield.

Nitrogen fertilization has produced no immediate response in growth or yield. No differences were secured in 1932 on plots receiving spring fertilization in March as compared with plots receiving none at this time. However, these latter plots made much weaker growth following summer pruning. Nitrogen fertilization three weeks before harvest had little or no effect on development of new canes after summer pruning when plants had received regular spring fertilization. This data would indicate that the storage system of the crown and roots acts as a reservoir of food materials throughout the year and must be considered in any fertilizer or pruning study. (C. F. Williams).

Dewberry Disease Studies. This project was started in 1926 for the purpose of determining the cause of the different cane blights and root rots, and to study the control measures for leaf spots, cane blights and root rots.

The specific cause of root rot was shown to be due to *Collybia dryophila* Fr. Three scientific papers have been published concerning the disease and the causal organism. Recent observations indicate that nutritional deficiencies, especially magnesium sulfate and infestation of nematode, *Caconema radicicola*, are inducive to the progress of the disease.

The irregular seasonal occurence of the leaf spots have interferred somewhat with studies on their control. As an example, the anthracnose disease was reported severe in 1925 but of no further economic importance until 1931, when it was again reported causing heavy loss. It appeared again during 1932, but was of less importance than during the previous season. However, heavy carry over infections on canes caused general spraying, which apparently lowered the infection during 1932.

The Cercospora spot, sometimes called blotch and Brown spot, caused by *Cercospora rubi* Sacc. has frequently caused defoliation during the late summer and autumn seasons. This disease seems to be confined to these periods, since it has not been found attacking the crop during the past harvest season. The infection occurs first on the old leaves, and gradually spreads along the canes to other leaves. The new leaves nearest to the ends of the canes were more resistant. It was shown that 4-4-50 Bordeaux

mixture will control this disease, but the control is of no economic value, since a study of the nature of the disease showed that economic production is not disturbed even when defoliation is very heavy.

The most prominent and destructive cane blight was found to be caused by *Leptosphaeria coniothyrium* (Fel) Socc. This fungus was found to attack the pruned spurs and to continue working downward below the new canes, cansing stunted growth and sometimes death. The disease works entirely above ground, and pruning old canes below the soil was shown to result in practical control.

During the past year studies were started on the relation of the nutritional requirements of the plant to root rot, but positive results were not obtained this season. (R. F. Poole).

The Fruiting of Collybian Dryophila in Pure Culture. Mycologia, Vol. XX, No. 1, January and February, 1928.

A Root Rot of Lucretia Dewberry Caused by a Variety of Collybia Dryophila Fr. Jour. Ag. Research, Vol. 35, No. 5, September, 1927.

A Variety of Collybia Dryophila Parasitic on Dewberry. Jour. Elisha Mitchel Scientific Society, Vol. 43, 1927.

The Relation of Types of Pruning to the Control of Coniothyrium Cane Blight. Submitted with C. F. Williams as a Station Bulletin.

FRUIT BREEDING

Raspberry. Although adverse conditions of drought and late spring freezes have been experienced during the past two years, selections of raspberry hybrids continue to show promise, although some self sterility is evident. Some of the black raspberry hybrids have some resistance to anthracnose and are being saved for further breeding. Tests plots of some of the better seedlings have been set out and have made satisfactory growth.

Dewberries. Of 344 Young selfed seedlings, only 6 were thornless, although 82 others had spines only. Of the Young x Austin thornless seedlings, 345 were thorny, 340 were thornless, and 76 had spines only. A late freeze in the spring killed most of the buds, but apparently most of the seedlings are self sterile. A seedling of Young x Lucretia that is 10 days earlier than Lucretia, firm fruited, prolific and good quality has been propagated for a plot test.

Peach. Seed from a seedling peach of good quality, ripening the first of October, have been saved. Crosses with the parent tree will be made during 1933. (C. F. Williams).

VEGETABLE INVESTIGATIONS

Vegetable Observation and Trial Garden Project. Since 1929 new varieties and strains of vegetables being offered by seedsmen have been tested out in the field. Selection, breeding and cultural practices have also been carried on with various vegetable crops.

During the spring and early summer of 1932 a large number of strains and varieties of vegetables were grown on the horticultural farm at Raleigh. These tests included sweet corn, tomatoes, peppers, egg plant, beans, peas, cantaloupes and squash. Results for this season are not

dependable on account of the unfavorable season. The new Pritchard variety of tomato is outstanding. Some selection and breeding work with lettuce and squash was also carried on. At the Lower Coastal Plain Station seed selection of sweet potatoes was continued. On a 1/200 acre plot where small seed sweet potatoes were planted directly in ridges in the field to grow vine cuttings for the main crop, only 430 vine cuttings were obtained up to July 10, or at the rate of 86,000 per acre. This would indicate an unsatisfactory yield of early vine cuttings by this method.

A paper was presented before The Southern Agricultural Workers in February, 1932, giving experimental and field results with North Carolina No. 1 Improved Strain of Porto Rico Sweet Potato. (Robert Schmidt).

The Influence of Varying Rates and Methods of Applying Concentrated Complete Fertilizers upon the Stand, Yield and Quality of Sweet Potatoes Grown on Norfolk Loamy Fine Sand (Currituck county). Work with fertilizers and methods of application for sweet potatoes was started in 1920 and is being continued. Results showing the effects of synthetic nitrogen and concentrated fertilizers on sweet potatoes are given in N. C. Station Bulletin No. 266, published in 1929. Another publication, giving the results of fertilizer experiments with sweet potatoes on Norfolk loamy fine sand, Portsmouth fine sandy loam, Norfolk sandy loam and Cecil sandy loam is now in the press. N. C. Station Bulletin No. 263, published in 1931, gives approved practices for sweet potato growers.

For sweet potatoes grown for early market on sandy soils, 1200 to 1,400 pounds per acre of an 8-4-8 mixture has been found best. On the sandy loam soils of the Coastal Plain where potatoes are grown for late harvest, 600 to 800 pounds per acre of an 8-4-10 mixture is recommended, while for the Piedmont and Mountain areas the same amount of a 10-4-8 mixture has proven most satisfactory, both recommendations being based upon field findings. (H. B. Mann cooperation Bureau Chemistry and Soils).

Some Studies on the Prevention of Diseases of Sweet Potatoes in the Field. This study began in 1926, and the purpose was to obtain and perfect a safe chemical that could be applied to the stems and roots of the plant immediately before transplanting in such strengths that would destroy the parasites that cause the four important plant borne diseases without injuring the sweet potato plant.

Results published in two technical bulletins and two popular bulletins give definite control measures for *Fusarium batatatis* Woll. and *Monilochaetes infuscans* Ell. and Hals., fungi that cause wilt and scurf diseases respectively. For the control of wilt or stem rot, 20-20-50 Bordeaux mixture and 1-10 Hydroxymercurichlorophenol are recommended. For the control of scurf, ground sulfur dust and 1-10 Hydroxymercurichlorophenol are recommended.

Similar studies of the control of two other plant borne diseases, black rot, caused by *Ceratostomella fimbriatum* (Ell. & Hals.) Sacc. & Ell., and root knot, caused by *Caconema radiciciola* (Greef) (Muell) Cobb. have been conducted during the past two years. The results indicate some control response of the black rot organism to mercury compounds. Weak solutions of mercuric chloride have shown very promising results in both

disease control and low chemical injury. The irregular development of the disease under field conditions, although heavy artificial inoculations were given, has made it more difficult to progress with these studies than with those on wilt and scurf diseases. Soil treatment with sulfur at the rate of 400 and 600 pounds to the acre greatly reduced the nematode infestation, but plant treatments have not given promising results. In this study it was found that soil infestation is the primary source of infection. (R. F. Poole).

A Chemical Control of Sweet Potato Scurf. Technical Bulletin No. 38, May 1930.

A Control for Sweet Potato Scurf. Bulletin No. 274, May 30, 1930.

A Chemical Control for Sweet Potato Wilt or Stem Rot. Technical Bulletin No. 35. March, 1929.

A Control for Sweet Potato Wilt or Stem Rot. Bulletin No. 273, May, 1930.

Some Studies on the Control of Seed Borne Diseases of the Sweet Potato. This study began in 1926, having the purpose of systematically determing the comparative value of disinfectants on the control of parasites carried over from one year to another on the sweet potato seed stock, and at the same time determine the effects of the disinfectants on the germination of the potato.

Formaldehyde 1-240 used for 10 minutes and mercuric chloride 1-1000 used for 8 to 10 minutes have both been used extensively for treating sweet potatoes. The results of these studies showed that formaldehyde does not give satisfactory control of the scurf fungus. The results are fully given in Technical Bulletin 38. It was further shown that mercuric chloride 1-1000 strength when used for 15 minutes does not give complete control, but does greatly reduce infection over the shorter treatment without increasing injury, which is noticeable at even shorter periods of treatment.

In the study of seed treatment for scurf control, the plant bed was used fairly satisfactorily, but it presented several obstacles in the study of the black rot fungus, which has a greater spreading range. The plant bed had to be eliminated because of the various factors involving experimental error. In the meantime, a most satisfactory method of growing the fungus profusely, developing the disease rapidly and determining the effects of any chemical on disease control and germination and injury of the potato was developed. This laboratory method brought the important factors of this study under control.

Using this method it was definitely shown that formaldehyde in any strength cannot be used satisfactorily for controling black rot, since severe injury to germination occured and the potato became more susceptible to saprophytic fungi when either strong solutions were used for short periods of treatment, or weak solutions were used for periods long enough to kill the fungus. The method devised and the results obtained with formaldehyde will appear in the Journal of Agricultural Research. Similar studies are being conducted with mercury compounds. (R. F. Poole).

A Comprehensive Study of the Effects of Formaldehyde on Ceratostomella fimbriatum and the Sweet Potato. Accepted for publication in the Journal of Agricultural Research. (R. F. Poole.).

A Study of Factors that Prevent the Development of Organisms that Cause the Diseases of Sweet Potato. This project has continued since 1926. Its purpose was to determine the characters of growth of specific organisms that cause diseases of sweet potatoes and varietal resistance.

When potatoes were grown with various fertilizers and later inoculated with fungi that cause the specific rots there was no evidence that any element affected greater susceptibility or resistance. Potatoes grown on light sandy soils were more resistant to surface rot, caused by *Fusarium oxysporium.* Potatoes washed or wet after harvest also became more susceptible to injury and the disease. Wilt was found to be of greater importance on sandy soils and of rare occurrence on clay soils. These studies tend to indicate that the fungus does not live on the latter types. Scurf was worse on fertile clay loams, especially when barnyard manure and legumes were plowed under. Alkaline reactions were found especially favorable for the development of scurf. No varieties were found resistant to the scurf disease, but varieties such as Norton Yam, which produced potatoes further away from the source of infection on the stem showed fewer diseased potatoes than did varieties such as the Nancy Hall and Jersey varieties which normally produce potatoes nearest to the stem. On deep sandy soils in dry seasons, these latter varieties showed less infection of the potatoes, since the potatoes developed further away from the stems. The Jersey varieties and Porto Rico variety were found most resistant to nematode, *Caconema radicicola* infestation.

"Knob and Elevated Veins" were found to result from hard soils and second growth, respectively.

Studies on susceptibility of sweet potatoes, harvested late, to various parasites indicate that potatoes may rot even under the best storage conditions if potatoes are harvested after cold rains and after November 1. Pythium, Mucor, and Rhizopus fungi, are the fungi most prominently associated with the rots. (R. F. Poole).

"Knob and Elevated Vein Disorders of the Sweet Potato". Accepted for publication in the Journal of Phytopathology.

The Nematode Disease of Sweet Potatoes. Bul. No. 265, April 1929, and in the Jour. Phytopathology, Vol. XVII, No. 8, 1927.

Studies on the Control of Sweet Potato Diseases in Storage and Transit. This project was started during 1926. The objects were to determine the species of fungi and other causes of economic losses of sweet potatoes in storage and transit, and the effects of various chemical treatments on the control of the parasites.

This study has shown that soft rot, caused by *Rhizopus nigricans* Ehr. is not of serious economic importance in storage banks, but may cause heavy loss of potatoes after being removed from the banks. This fungus was found to cause heavy loss of potatoes immediately after the potatoes are stored when the heating and ventilating were not sufficient to bring about immediate callousing of the tissues. Resorting of potatoes after storage in order to remove a few potatoes diseased with *Rhizopus nigricans* was found to increase the losses, but keeping the temperature around 85 degrees Fahrenheit until diseased potatoes were dried out, gave satisfactory control eliminating the necessity of removing the diseased potatoes.

The greatest losses from this disease occurred following repacking, since the bruised potatoes became infected from the heavy spore inoculum produced on potatoes that were dumped on the floor and allowed to rot. Heavy losses in transit were traced to this source of infection.

Losses in banks were found to be caused by many fungi, some of which have not been accurately determined. Many of these fungi were secondary to causes of break down due to heating immediately after the potatoes were banked and to water leaking through the covering.

A large number of chemicals were applied to the potatoes just preceding storage. These treatments were found to effect some reduction in losses caused by both soft rot and black rot diseases. Potatoes treated with lime, were well protected from *Rhizopus nigricans*, cause of soft rot. Bordeaux mixture suppressed the soft rot and also black rot diseases. Heavy infections taking place in the field have interferred with greater effectiveness of these and other chemicals.

These studies indicate that most of the black rot infections occur in the field, although the disease may not appear until after the potatoes are stored for two weeks. The loss in storage was closely related to the percentage of plants infected. The present storage system has not indicated any control of black rot after potatoes are already heavily infected when stored. Rapid drying at a temperature of 85 degrees Fahrenheit prevented germination of many spores. The causal fungus, *Ceratostomella fimbriatum*, dies in the laboratory every summer, even when well established on a good medium, or in the raw sweet potato, indicating that it does not live over in storage houses. (R. F. Poole).

Approved Practices for Sweet Potato Growers. Bulletin No. 263, Feb. 1929, and Revised 1931.

Sweet Potatoes Infected by *Schizophyllum Commune*. Jour. of Elisha Mitchell Scientific Society, Vol. 45, No. 1, pp. 137-139. Plates 7-9, Nov. 1929.

Irish Potato Breeding. This is a cooperative project with the Office of Horticultural Crops and Diseases, U. S. D. A., and was begun in 1929.

The purpose of this work is the development of blight resistant, early, smooth and high yielding varieties adapted to both the late and early potato sections of the state, and to study the genetics of earliness, type, disease resistance, etc., in the potato.

Katahdin, formerly U. S. D. A. seedling No. 42667, has been tested in both the East and West for three years, and results of tests reported in previous reports. The performance of this variety has been such as to warrant introduction in the West, or late potato section, next year. It will not compete with Irish Cobbler for the early market in the East, due to the fact that it is from 18 to 21 days later and does not give sufficient yield when dug immature.

Through the cooperation of Dr. J. C. Miller, of the Louisiana Experiment Station, disease readings were made on hill selected seed stock of Katahdin early last spring and his report received before planting time in our mountain section. Hills showing disease were discarded before planting and fields isolated and rogued during the growing season. From two plantings approximately 50 bushels of registered seed stock is available for further increase and distribution to growers of certified seed.

The past year approximately 6,500 seedlings were grown at Raleigh, and from this number about 630 selections made for single hill increase next year.

One tuber each of 151 seedlings grown in 1929 by the U. S. D. A. at Presque Isle, Maine, were received in October, 1930, and planted at Newland, in the spring of 1931. Of this number 18 have been selected for comparative yield tests next year, 63 saved for further observation, and the balance discarded.

One hundred and thirty-two selections, saved from seedlings grown at the Mountain Branch Experiment Station and Newland, were grown the past year in 10-hill plots. Of this number 31 were saved for comparative yield test and further increase, 31 for further observation, and the balance discarded.

One thousand three hundred and eighty-five selections were grown for single hill increase, and comparative yield tests with 17 seedlings and named varieties continued in both the East and West. One new seedling, U. S. D. A. 44,428, was added to the test.

Deficient rainfall has made difficult the determination of varietal performance and in consequence, a larger number of selections have been saved than would have been the case under normal seasonal conditions. An epidemic of late blight has not occured in the past three years, and it has therefore been impossible to study resistance of plants to this important disease under field conditions. (M. E. Gardner, Robt. Schmidt).

Fertilizer Requirements of Early Irish Potatoes When Grown on Bladen Fine Sandy Loam (Beaufort County). These fertilizer investigations with Irish potatoes, started in 1928, are being continued. A preliminary report of work of three years is given in Agronomy Information Circular No. 54, of this Station, and another bulletin is being prepared covering the results of the past five years as a whole. In Bulletin 279, of this Station, is given, among other things, the approved fertilizer practices for Irish potato growers. Results thus far secured show that a fertilizer containing 7 percent available phosphoric acid, 5 percent nitrogen, and 5 percent potash, applied at the rate of 2000 pounds per acre, is most satisfactory. Nitrogen should be derived approximately one-third from organic sources and two-thirds from inorganic sources. Muriate of potash has been found to be the most economical source of potash in the fertilizer mixture. (H. B. Mann, cooperation Bureau of Chemistry and Soils).

Corn Earworm. The second complete year of studies on the hibernation of the corn earworm offers some interesting comparisons with the first year. In 1931 the bulk of spring emergence of moths came from cages in which worms had gone into the ground at periods ranging from August 19 to September 20, 1930. For periods August 11, or earlier, most of the moths emerged the same year, and for periods later than October 1, few moths emerged at all. In 1932 spring emergence of moths was greatest from the lot of worms going into the ground September 4 to 8, 1931, but a large percentage emerged from worms pupating up to October 12. Worms pupating August 21 to 25, 1931, gave a large percentage of moths in 1931, but a small number the following spring. The difference in the two years is probably explained by the prolonged warm weather in the fall of 1931. The fact that late August worms mostly transformed to moths the same

year, may partly explain the reduced infestation of earworms in 1932, for after August there is a relatively small amount of corn young enough for earworms.

Weekly records of earworm eggs on fresh silks as an index of infestation showed reduced infestation as compared to normal years. There was a decrease during the last part of July, followed by an increase in August to a maximum on August 24, when the count gave an average of eleven eggs per ear and 96% of the ears with eggs. The date of the maximum egg count for 1931 was August 24, and for 1930, August 19.

Experiments for the control of earworms in sweet corn roasting ears were continued. Some of the cinchona alkaloid compounds were applied to silks for the purpose of making them distasteful, but the treated ears became as badly infested as the checks. Rows were treated by spraying the ears twice, 4 days interval, during the silking period, with the following combinations: (1) Nicotine sulphate—oil, 1 (40%)—10-500, infestation in roasting ear stage 62%; (2) Nicotine tannate (nicotine content .06%), 63% infested; (3) Nicotine sulphate-molasses, (1 to 500, molasses 1 to 4 of water), 61% infested; (4) Bordeaux-oil-lead arsenate, (4-6-50, oil 1%, lead arsenate ½%), 35% infested; (5) Copper Oleate (copper sulphate 1, potassium oleate 5, water 250), 66% infested; comparable check rows, 64% infested. Rows were treated twice, 6-day interval, by wetting the silks, including part within tip of husk, with the following sweetened poisons: (1) Molasses (1 in 4 water)—lead arsenate (1%), 36% infested; (2) honey (1 in 4)—lead arsenate (1%), 63% infested; (3) honey (undiluted)—lead arsenate (1%), 39% infested; (4) Molasses (1 in 4)—copper cyanide (1%), 48% infested; (5) Check, 51% infested. Rows were treated twice, 5-day interval, by spraying entire ears with the following: (1) lead arsenate (1%)-fish oil (1 to 400), 43% infested; (2) Barium fluosilicate (1%)-fish oil (1 to 400), 41% infested; (3) Check, 51% infested. Two varieties were treated once, when silks were starting to dry, by clipping silks off and applying a few drops of ethylene dichloride, 3 pts.—carbon tetrachloride, 1 pt. with results as follows: Country Gentleman, 41% infested; Check, same variety, 51% infested; Golden Giant, 19% infested, Check, same variety, 54% infested. The better results on Golden Giant were due to the longer husk. In September some Adams early and Truckers Favorite were treated as above, with the same fumigant, and also carbon-disulphide.

	ADAMS Ethylene dichloride Sept. 2	ADAMS Carbon disulphide Sept. 2	TRUCKERS Ethylene dichloride Sept. 5	Check
Infested Sept. 5	50%	49%		99%
Infested Sept. 11	55%	61%		100%
Infested Sept. 16			59%	100%

Worms in treated ears were generally smaller and had fed on ear to less extent than in checks. A number of the treated ears were injured at the tip by the fumigant.

Small strips of soft paper impregnated with paradichlorobenzene pushed into the tip of the husk, gave 12% infestation, compared to checks 78% infested. The treatment gave a disagreeable taste to the upper portion of the ear. Napthelene used the same way was not as effective. (B. B. Fulton).

INVESTIGATIONS IN FLORICULTURE

Tests of New and Standard Ornamental Flowering Plants. This project has been active since 1921. Some of the results have been reported in trade magazine articles during previous years, and during the past year one such article has been published which gave one year's results from our greenhouse rose variety test.

Results of Herbaceous Perennials. Seventy-seven different kinds of herbaceous perennial flowering plants were included in the trial again this year. Notes were taken, as during previous years, on the adaptability of these plants to the environmental condition under which they were growing. Sufficient information has been obtained for a popular bulletin on the culture of herbaceous perennials under North Carolina conditions. This trial has shown quite conclusively which of the perennials in the test are best adapted to the environment under which they were grown. (G. O. Randall).

Bulbs. Fifty-five varieties of tulips were included in the trial this year, nine more than in previous years. The records have been compiled on the yield of bulbs of fifty-five varieties for the years 1929, 1930, 1931 and 1932. A summary of these records shows that only a limited number of varieties, twenty-one, have shown an increase from year to year in number of bulbs produced. Twenty-two varieties have produced each year about the same number of bulbs as was planted the previous fall, and ten varieties have gradually shown a decrease in yield over the quantity planted the previous fall. These results indicate that in the vicinity of Raleigh only a limited number of varieties of tulips will show an increase in yield of bulbs each year over the preceding year when all bulbs produced are planted each year. Following is a list of varieties that have shown a constant increase in yield when all of the bulbs were planted each year:

*Diana, (SE) Mr. Van Derhoett, (DE), Scoonoord, (DE), Bouton D'Or, (C), Gesneriana Major, (C), John Ruskin, (C), Inglescomb Yellow, (C), Inglescombe Pink, (C), Pride of Inglescomb, (C), Alcidia, (B), Chester J. Hunt, (B), Dryad, (B), Few Ardent, (B), Clara Butt, (D), Dutchess of Hohenburg, (D), Mr. Farncombe Sanders, (D), Painted Lady, (D), President Harding, (D), Pride of Haarlem, (D), Belle Irlandaise, (By), Iduna, (R). (G. O. Randall).

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*Abbreviations used in classifying varieties of tulips:

SE—Single Early
DE—Double Early
C—Cottage
B—Breeder
D—Darwin
By—Bybloom
R—Rembrandt

Roses. A trial garden containing thirty varieties of roses was started early last spring. The plants were contributed by the Conrad-Pyle Co. West Grove, Pa. The garden was made to include thirty beds with ten plants of a single variety in each bed. For the thirty varieties the following, during the past growing season, have made the most vigorous growth, have shown resistance to disease, have flowered in profusion and have produced good quality flowers:

Charles K. Douglas, National Flower Guild, Red Radiance, Grenoble, Etoile de Hollande, Editor McFarland, Radiance, Mrs. Charles Bell, Thomas A. Edison, Ariel, Etoile de Feu, Kardinal Piffl, Mrs. G. A. Van Rossem, Dutchess of Wellington, Mrs. Pierre S. Du Pont, Kaiserin A. Viktoria, Nuntius Pacelli, Abol.

Dahlias. Twenty-nine varieties were grown this year. The following varieties have been outstanding in beauty and perfection of flower and stem as well as in vigor of plant:

Treasure Island, City of Trenton, Fort Monmouth, Mrs. I de Ver Warner, Ida Perkins, Jersey's Beauty, Congressman Wolverton, Rodman Wannamaker, Jane Cowl, President Hoover. (G. O. Randall).

Greenhouse Rose Tests. Fifteen varieties of greenhouse roses were tested to compare as many of the newest varieties as possible with some of the older standard varieties. The following varieties were included in the test during the past season: Premier Supreme, Briarcliff, Paul Pierson, Rapture, Rose Hill, Planet, Hollywood, E. G. Hill, Templar, Talisman, Roslyn, Joanna Hill, Hoover, Pernet and Caledonia. The five highest yielding varieties, based on one year's results, are Talisman, Hoover, Joanna Hill, Briarcliff, and Roslyn, listed in order from highest to lowest. It was of interest to note that Talisman and Hoover produced equal total yields, but Hoover produced 43.9 percent more Grade 1 flowers than Talisman. The Hoover variety, however, has the disadvantage in that the flowers open rather quickly after they are cut and are more single than the other varieties. In addition to yield records, notes were kept on vigor of plants and on disease resistance. One variety, Caledonia, was found to be very susceptible to powdery mildew.

The results of this test have been reported in full to the commercial growers in an article printed in one of the leading trade magazines. (G. O. Randall, J. G. Weaver).

HUMAN FACTORS IN AGRICULTURE

Factors Conditioning the Living of Thirty-five Typically Successful Farm Owner Families in Wake County. The objectives of this project are: First, to investigate the factors which lie within the family organization and condition the standard of living, and to analyze these factors; Secondly, to discover whether the case study method may be adapted to research with farm families. The majority of the families have been cooperative in the study and have not only indicated a willingness to be of service, but many have said that the interviews had proved helpful to them. The collection of data and the case visiting have been completed. The work has been advanced to a point where these data have been analyzed and are now being classified and written up for final report. The manuscript will be submitted for publication in 1932. Conclusions and results will be included in the manuscript.

Tentative preparations have been made for another study. Data with regard to the families of candidates for Master Farm Homemaker in North Carolina are being classified and tabulated with a view to their investigation and study. (Myra deHaven Woodruff).

Methods and Practices of Cooperative Purchasing and Marketing Associations. The objectives of this investigation are (1) To obtain accurate information relative to the purchasing and marketing of North Carolina agricultural products, particularly through cooperative agencies. (2) To study in detail the methods and practices of typical cooperative purchasing and marketing associations. And (3) To work out a program for coordinating cooperative purchasing and marketing efforts in North Carolina. The project has been active since July 1, 1931. In connection with the past year's work on this project, a survey was made of cooperative marketing and purchasing activities of 57 vocational teachers for the year 1931. This study which was prepared as a paper for the State Conference of Vocational Agricultural Teachers indicated the importance and limitations of such work and the necessity for coordinating cooperative effort in this state. From information gathered from the general project, it is clear that the cooperative movement is rapidly expanding in North Carolina, particularly through the formation of mutual exchanges. The results of this study should prove of great assistance in developing a statewide cooperative program based on strong local cooperative associations. A large amount of data has been gathered which are now being tabulated and analyzed. The study will be completed by July 1, 1933. (J. G. Knapp).

On January 1, 1932, due principally to a change of personnel, a new program of research in rural sociology was initiated. The following project has been outlined and approved for study:

Farm Family Functions and Relationships. The fundamental objective of this project is to discover the basic social principles in the development and maintenance of a stable and rich family life on the farm. As a means of obtaining our fundamental objective we have set up two concrete intermediary objectives: (1) To discover the extent to which members of farm families cooperate and associate with each other, and what their relationships are in carrying on family and community activities and

functions. (2) To discover and to measure some of the factors which cause more or less cooperation and association in the farm family; such factors as the consolidated school, improved roads, nearness to community and urban centers, use of automobiles, increase in organization, and family composition and structure. The basic data of this investigation was obtained in two communities of Iredell county—Harmony and Troutman. Four hundred families were interviewed by the writer and four mature assistants working under his supervision. Schedules were used in recording the results of the interviews. Each survey worker made notes of any unusual items of information about the family interviewed. In addition to the family data, information was obtained from eight hundred school children who were, for the most part, children of the families studied. School teachers cooperated in obtaining the information from the pupils and supplied also certain significant data about the child's personality and his record in school.

The data of this study have been transcribed to standard columnar tabulating pads, and now certain sections of the data are being tabulated and analyzed by means of Hollerith Tabulating Machine equipment. We are not prepared at this time to publish any of the preliminary results. (C. Horace Hamilton).

RESEARCH OF THE TEACHING STAFF

Ten project leaders of the Experiment Station conduct one or more college courses. Members of the full time teaching staff conduct one or more research projects and contribute to special phases of the Station program. Contributions of the teaching staff to the program have been noted under project reports.

The research in the Department of Zoology and Entomology is centered around the study of insects and other animals of economic importance and around the taxanomy of certain insect groups. In general, the work on taxanomy is carried on by members of the teaching staff who have no regular time for research but use off hours during the week for this work. Taxonomic work lends itself to such irregular hours because it can be laid aside at any time. Economic studies cannot be pursued at odd hours, as this work requires careful and detailed attention at specified times.

Biology of the Homoptera. Chief emphasis during the past year has been placed on the completion of the Catalogue of the Homoptera of the World. As noted in the Fifty-fourth Annual Report, the first part has been printed. The second and third parts are in the hands of the printer and the subsequent parts are being prepared for publication. (Z. P. Metcalf).

A great deal of taxonomic work is in hand at the present time. Extensive collections have been received during the past year from the Philippines, Java, China, East Africa, Panama, and Brazil. The studies of these insects from China, Panama and Cuba are practically ready for publication. These studies furnish the foundation for future economic work and, therefore, are of great value to the advancement of economic Entomology in those countries.

The Genetics of Habrobracon. Continued study of factors concerning the production of biparental males in the parasitic wasp, Habrobracon juglandis, has added evidence to conclusions previously reported and has yielded evidence for several additional conclusions. Normally males develop from unfertilized eggs and thus show maternal inheritance, but from certain crosses a few males are produced which have been shown to develop from fertilized eggs. Unrelated stocks when crossed produce no such males, but segregates from such crosses can be mated to either original stock and produce biparental males. By continued breeding of such derived strains up to stocks unrelated at the beginning of the experiment, it has been possible to increase the number of biparental males produced. Thus hereditary factors not only determine the possibility of the production of biparental males, but also regulate the proportion of them to the total number of offsprings developing from fertilized eggs. Sufficient evidence has been derived from work carried out here and elsewhere to demonstrate that whatever causes a fertilized egg to develop into a male occurs at fertilization, or very soon afterwards. Just what occurs at this time is now being studied.

Mutant genes are being tested for linkage, and in cooperation with workers at other institutions, progress is being made gradually in determining the linkage relationships of the known genes. At the present time over forty factors are known, and six linkage groups have been established. (C. H. Bostian).

PUBLICATION OF RESEARCH

The major purpose of the Division of Publications is to edit and publish findings by the research workers of the North Carolina Experiment Station so that the results of these findings might be available to the citizens of the Commonwealth. This means that the editorial staff confers with the director of the Station and the research workers about their proposed publications; plans and edits the bulletins, attends to the advertisement and distribution of all publications, and prepares releases to the Press commenting on the work and results of the Station staff.

In this work, the editorial staff uses all of its facilities which include a special service to the weekly newspapers each week, spot releases to local news agencies such as the Associated Press, articles sent directly to the farm pages of the principal daily newspapers, special reports to farm magazines, and comments in Extension Farm-News, the house organ of the Agricultural Extension Service. Not only are progress reports made on experimental findings through these agencies, but all publications are commented upon as issued. The publications are offered to the public and supplied promptly on request.

The division of publications does not maintain a large and unwieldy mailing list in which there must be considerable waste, but distributes all bulletins through the county agent service, the vocational teachers, and directly on request. In this way there is little waste of bulletins such as would be had through indiscriminate mailings. Directors of other Stations and libraries are exceptions to this rule, as these get copies of all publications issued.

Publications. In printing publications of the Station extreme care is used that the expenditure of public funds may bring about the best results. The probable need of a bulletin is carefully analyzed and the number of copies printed is based on this need. However, it is realized that as a public institution, the findings of the Station should be available to all those needing the information, and for that reason enough bulletins to supply the probable need are printed. Care is taken to eliminate all waste and useless publications.

During the fiscal year ending June 30, 1932, the Station published only four bulletins. Eight were edited and prepared for printing, but lack of funds prevented all of these being published. Of the four published, two were general bulletins in an edition of 9,000 copies, and two were technical bulletins in an edition of 4,000 copies, making 13,000 bulletins printed. Of this number, 4,624 copies were distributed through the mailing lists, and 596 copies to special lists as requested by the authors. On individual requests, 15,978 of these and other bulletins were distributed, making a total mailing of 21,298 copies during the fiscal year.

Considerable service work was also done for the Station during the year. This included the preparation of 81,194 circular letters, 8,500 letterheads for the different offices and divisions, and the printing of 5,000 envelopes for the same group. The office of the editor assisted in preparing the various forms used by the Station and saw that these were properly printed at the most economical price.

The office also has a subject matter mailing list containing approximately 16,000 names to which envelopes are addressed from time to time as requested by Station workers. Records show that some 70,000 envelopes were thus addressed during the fiscal year. As in the past, the assistant agricultural editor gives a large part of his time to the publication work of the Experiment Station.

The list of publications prepared, printed and distributed by the Station for the year ending June 30, 1932, is as follows:

POPULAR SERIES

No.	*Title*	*Issue*
278.	Farm Business Accounts	4,000 copies
279.	Approved Practices for Irish Potato Growers	5,000 copies

TECHNICAL SERIES

41.	Value of Peanuts for Growth in Pigs	1,500 copies
42.	Source and Care of Cotton Planting Seed in Relation to Length of Staple	2,500 copies
	Total	13,000 copies

TECHNICAL PAPERS

No. *Title*

49. Distribution of Vitamin B Complex and Its Components in the Peanut. Halverson and Sherwood.
50. Some Characteristics of Pecan Varieties as Determined by Cracking Test.—Gardner and Beaumont.
51. Performance Records of Pecan Varieties in North Carolina.—Beaumont, Gardner and Schmidt.
52. Preliminary Report on Relation of Soil Moisture and Leaf Area to Fruit Development of the Georgia Belle Peach.—Ivan D. Jones.
53. Effects of Light and Temperature on the Growth and Tuberization of Potato Seedlings.—Beaumont and Weaver.
54. Seasonal Variations in Nitrogen Concentration in Twigs of Peach Trees Under Sandhills Conditions.—C. F. Williams and J. H. Beaumont.
55. Preliminary Report of the Effects of Time and Rate of Nitrate Fertilization on the Growth and Yield of Elberta Peaches.—J. H. Beaumont and C. F. Williams.
56. Effect of Age of Plant on Flower Production and Yield of Strawberries in North Carolina.—Morrow and Beaumont.
57. Oxidation-Reduction Potentials and the Hydrogen-Ion Concentration of a Soil.—L. G. Willis.
58. Knob and Elevated Vein Formation on Sweet Potato Roots.—R. F. Poole.
59. A Comprehensive Study of the Effects of Formaldehyde on Ceratostomella Fimbriatum and the Sweet Potato.—R. F. Poole.
60. Hard Seed in Korean Lespedeza.—Gordon K. Middleton.

The effect of liming soils on the availability of manganese and iron, by L. G. Willis (Jour. Am. Soc. Agr., Vol. 24 (1932), pp. 716-724).

Oxidation-reduction potential and the hydrogen-ion concentration of a soil, by L. G. Willis, (Jour. Agr. Res. Vol. 45, (1932), pp. .....).

Effect of Applications of Nitrate or Soda to Dormant Peach Trees.—C. F. Williams, N. C. Acad. Sci. 1932.

Pecan Investigations in North Carolina.—Robert Schmidt, National Pecan Growers Association, 1932.

Strawberry Fertilizer Investigation.—Robert Schmidt and J. H. Beaumont, Southern Agricultural Workers, 1931.

Experimental and Field Results with North Carolina No. 1 Improved Strain of Porto Rico Sweet Potato.—Robert Schmidt, E. B. Morrow and H. R. Niswonger, Southern Agricultural Workers, 1932.

North Carolina Rose Variety Trial Tests.—G. O. Randall and J. G. Weaver, Florists Review, 1932.

AGRONOMY INFORMATION CIRCULARS

62. Outline of Agronomy Work Being Conducted in North Carolina, by the Staff.
63. The Importance of Soil Conservation, by H. H. Bennett, Federal Bureau of Chemistry and Soils.
64. Results of Strawberry Fertilizer and Tillage Experiments, by R. A. Lineberry, J. J. Skinner, H. B. Mann and C. B. Williams.
65. Shall Farmers Exchange Their Cotton Seed for Meal This Year, by C. B. Williams.
66. Legume Inoculation, by P. H. Kime.
67. Soil Types of North Carolina Found Suited to the Growth of Different Crops, by C. B. Williams.

FINANCIAL STATEMENT

The following is a certified statement of the receipts from the Treasurer of the United States, supplementary funds from the State Department of Agriculture, and sales from the Station farms, with a record of their disbursement:

THE NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION,
in account with the UNITED STATES APPROPRIATION, 1931-32.

Dr.

	Hatch Fund	*Adams Fund*	*Purnell Fund*
To receipts from the Treasurer of the United States, as per appropriations for the fiscal year ended June 30, 1932, under acts of Congress, approved March 2, 1887 (Hatch Fund), and March 16, 1906 (Adams Fund), and February 24, 1925, (Purnell Fund)	$15,000.00	$15,000.00	$60,000.00

Cr.

Personal services	$13,420.33	$12,903.13	$49,333.02
Supplies and materials	270.07	637.13	5,046.28
Communication service	74.07		131.55
Travel expenses	765.61	358.51	2,921.15
Transportation of things	28.09	17.69	113.20
Publications	62.23		819.39
Heat, light, water and power		130.36	133.13
Contingent expenses	72.30		295.57
Equipment	157.30	952.18	1,206.71
Buildings and land	150.00		
	$15,000.00	$15,000.00	$60,000.00

THE NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION,
In account with FARM AND MISCELLANEOUS RECEIPTS.

Dr.

State Department of Agriculture	$41,500.07
Sales	11,132.67
Special endowments, industrial fellowships, and similar grants	3,359.75
Miscellaneous	79.35
	$56,071.84

Cr.

Salaries	$29,202.98
Labor	5,911.31
Stationery and office supplies	617.36
Scientific supplies, consumable	360.89
Feeding stuffs	3,350.52
Sundry supplies	1,719.68
Fertilizers	1,134.64
Communication service	902.44
Travel expenses	5,696.37
Transportation of things	151.24
Publications	42.45
Heat, light, water and power	598.28
Furniture, furnishings and fixtures	495.15
Library	392.21
Scientific equipment	92.62
Livestock	1,100.50
Tools, machinery and appliances	847.72
Buildings and land	1,944.30
Contingent expenses	1,282.97
Unexpended balance	228.21
	$56,071.84

We, the undersigned, duly appointed auditors of the expenditures from Federal appropriations reported herein, do hereby certify that we have examined the books and accounts of the North Carolina Agricultural Experiment Station for the fiscal year ended June 30, 1932; that we have found the same well kept and classified as above; and that the balances, receipts, and disbursements are as follows:

	Hatch Fund Act of Congress March 2, 1887	*Adams Fund Act of Congress March 16, 1906*	*Purnell Fund Act of Congress Feb. 24, 1925*	*Total All Funds*
Unexpended balance brought forward from preceding year	none	none	none	none

Receipts for the year from the Treasurer of the United States	$15,000.00	$15,000.00	$60,000.00	$90,000.00
Total Federal Funds	15,000.00	15,000.00	60,000.00	90,000.00
Disbursements for the year	15,000.00	15,000.00	60,000.00	90,000.00
Unexpended balance June 30, 1932	none	none	none	none

Proper vouchers for all of the above disbursements are on file and have been examined by us and found correct.

And we further certify that the expenditures have been solely for the purposes set forth in the acts of Congress approved March 2, 1887, March 16, 1906, and February 24, 1925, and in accordance with the terms of said acts, respectively.

(Signed) R. Y. WINTERS,
Director of the Experiment Station.

Auditors.

A. F. BOWEN,
Financial Office of the Institution.

E. C. BROOKS,
President-Comptroller.

Attest:

A. F. BOWEN,
Custodian of the Seal.